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The Mining Magazine

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EDITORIAL

THE view that nickel production in the "free world" has now caught up with consumption has been supported by the announcement last month that the International Nickel Co. of Canada, Ltd., is to curtail its mine production by approximately 10%. The large stocks of nickel at present available to industry are expected to continue to climb and unless business in Canada and the United States shows a quick upturn a further cut back in production may become necessary. The company's nickel production capacity at Sudbury has risen, it is stated, to 300,000,000 lb. per year and full output can at any time be resumed with a minimum of delay. Long-term plans for further increased capacity are not affected by the cut back in production and the programme in northern Manitoba is to continue on schedule.

IN 1953 the National Research Council of Canada was asked to make a fresh study of a problem that has long worried seafarers off the coast of British Columbia. There the notorious "Ripple Rocks," a shoal created by shallow underwater rock peaks, have long been a menace to those attempting the "Inside Passage" through the Seymour Narrows. Now, however, as the result of mining work that has been under way since 1955 the "Rocks" have been blasted away. Following exploratory boring work from Maud Island a shaft was sunk and a 2,400-ft. tunnel driven under the rocks permitting 300-ft. rises to be put up and prepared for blasting. This has now been accomplished successfully and it is hoped that a menace to navigation will have disappeared for ever. The work on the project was finally carried out by the Northern Construction Company of Vancouver and J. W. Stewart, Ltd., jointly with the Boyles Bros. Drilling Company. Dr. Victor Dolmage, a geologist well-known in British Columbia, having all through acted as adviser to the Council and its consultants, finally had the honour of setting off the "big blast."

Commonwealth Raw Materials

At the end of March the Commonwealth Economic Committee issued its latest report dealing with the situation in the constituent nations as it affects a wide range of mineral and organic materials and the main sources of energy.[1] This report forms the first part of a comprehensive survey which precedes a second volume to contain more detailed studies of the raw materials position in each Commonwealth country. The work under review deals with production, consumption, trade, and prices of raw materials, with Commonwealth sources of energy, and with some diverse trends and developments in those fields, a "summary" and "commentary" giving the main features of the volume and presenting a general picture of the position which obtains. A short "conclusion" suggests future work on raw materials by the committee.

The committee's report shows quite clearly that Commonwealth production in the post-war years has been well above pre-war levels for most commodities and has been rising strongly. Moreover Commonwealth countries have provided a large share, often larger than before the war, of many of the most important raw materials. They supplied, for instance, more than three-quarters of the free world total of platinum metals, nickel, gold, corundum, asbestos, mica, coir, and jute and two-fifths or more of the manganese, ilmenite, chromium, tin, diamonds (by value), wool, rubber, castor seed, and kapok. This massive growth, it is suggested, owes much to developments in Canada, where large-scale surveys and heavy capital investment have brought new reserves of minerals and hydro-electric energy under exploitation. The considerable increases of production in the sterling countries of the Commonwealth were not, however, sufficient wholly to maintain their relative position in the free world, although as results began to flow from increased expenditure on surveying and exploitation the position began to improve.

[1] A Review of Commonwealth Raw Materials, Vol. I. London: H.M. Stationery Office. Price 16s., post free.

In spite of the thorough way in which the growth of Commonwealth trade in raw materials is followed through the three major phases of the post-war period—reconstruction and rising prices to 1949, the Korean boom and the post-Korean falls, and the subsequent renewal of industrial activity—it appears that there is, as yet, no evidence that the Committee is planning for the future. Witness the fact that by the middle of last year some commodities—such as, iron and steel, coal, aluminium, jute, and wool had continued to rise in price, while others, such as, hides, rubber, and timber showed little change and yet others, like lead, zinc, and copper (after reaching a record level in early 1956) had declined. Minerals figure strongly in the survey conducted, the report pointing out, for example, that much is being done to exploit known reserves of minerals and to discover new deposits by systematic surveys, to conserve land and improve the yields from it, and to open up more land for development. In spite of this, however, there remains it would seem the need to ensure a more unified direction of effort.

Diamonds in British Guiana

In a recent publication of the British Guiana Geological Survey the literature on the diamond resources of the Colony has been carefully surveyed and summarized.[1] Since the first discovery of diamonds in the area in 1887 " as a result of placer gold mining " to the end of 1954 some 2,583,300 metric carats have been recovered. Until 1919 the annual diamond recovery in British Guiana was less than 20,000 carats, but this rose to a peak of 214,474 carats in 1923 (168,000 carats coming from the Mazaruni field) thereafter steadily decreasing to the lowest figure of some 15,000 carats in 1945. The output in 1954 was 30,075 carats. Since 1912, the report states, practically all production has been by the individual itinerent prospectors known as " pork-knockers," their activities being largely determined by the price of stones. From 1900 to just before the 1914–1918 war the price was $5 (B.W.I.) per carat. In that period of conflict, however, all stones were by Royal Proclamation sent to the United Kingdom and the purchase price increased to about $10 per carat. In 1920 prices reached $35 and there was a corresponding spectacular increase in production, but by 1931 prices and production had fallen to $8 and about 65,000 carats, respectively. At present the average price is about $40 per carat but there has not been a corresponding production increase, which indicates that the present fields are becoming exhausted.

The origin of the diamonds in British Guiana is still uncertain, but the situation of " deposits on or near the Pakaraima Plateau, or near material derived from those mountains or the rivers draining those mountains and to some extent their mineral content, strongly suggests their derivation from the rocks of the Pakaraima Plateau." If this be the case then there are two possible groups of source rocks—namely, the sandstones and conglomerates or the gabbro sills. It is considered most likely that diamonds are derived from the sandstones and conglomerates of the Roraima Formation. " It does not seem likely that a $\frac{3}{8}$-carat diamond would come from a fine-grained dolerite," although it is possible that some diamonds have originated in the large gabbro or dolerite sills which traverse the Pakaraima Mountains. However, " whether diamond is derived from the sandstones and conglomerates of the Roraima Formation or not there is no doubt that these rocks could not be the primary source. If they do contain diamonds they are merely host rocks. The primary origin, therefore, remains unknown."

The report under review is not too optimistic about the future of the industry. Indeed, it is thought that the days of the small parties of prospectors working in individual claims are numbered and that the main potential of the diamond industry lies in the large-scale mechanized exploitation of the terrace deposits. It has been estimated that there is 40,000,000 cu. yd. of gravel in the Kurupung fields, some 20,000,000 of which is potentially diamondiferous, the average thickness of the pay gravel being roughly 2·5 ft. It is believed that the minimum value per cu. yd. at which beneficiation could be considered is $\frac{5}{16}$th carat and that a profitable enterprise could be founded on $\frac{1}{2}$ carat per cu. yd. In addition to this possibility alluvial diamond mining might be revived in the Marlissa area, upper Berbice

[1] " Diamond Resources of British Guiana." Compiled by E. R. POLLARD, C. G. DIXON, and R. A. DUJARDIN. Georgetown, Demarara: B.G. Geological Survey. Price $1·00.

River, which is adjacent to a large outlier of rocks of the Roraima Formation, if intensive prospection is carried out. In the event, the report concludes, the small-scale individual miner will probably eventually be driven to prospecting on the inhospitable plateau where it is quite impossible for diamondiferous alluvial deposits on the scale of the Mazaruni fields to be found even if small economic deposits may be discovered there.

Conveying Coal Hydraulically

The development of the system of raising mineral to the surface in a vertical column of water has been followed closely in these columns since it was first successfully demonstrated in the United States.[1] It is now possible, however, to consider hydraulic transport in yet another connexion—that is, as a matter of hygiene. In a recent report issued by the Minister of Power [2] attention is called to the greatly increased dust hazard created by the introduction of power loaders underground in British coal mines. Although such machines are equipped for wet cutting it has been found that to suppress the dust without seriously affecting the condition of the roof and floor intensive infusion and water spraying are required. Then, to prevent dust dispersal while the coal is on its way to the surface, carefully-sited spray nozzles, suitably shrouded, have to be fitted over the conveyors. To overcome this it was decided at one mine in the Coal Board's No. 1 Area to experiment with the hydraulic transport of the coal. Interest in the matter was intensified after the Creswell disaster, says the author of the report noticed here, and now the transport of 6-in. coal in a 9 in. diameter pipeline is regular practice.

This method of transporting coal, it is considered, now that it has been shown to be practicable, has many obvious advantages. Hydraulic conveying would do much to prevent the large dust deposits which collect along conveyor installations and other mine roadways, particularly in inaccessible places. Such dust, " which remains undisturbed until raised into potentially dangerous clouds," must always be a lurking hazard. Using this type of handling would obviously therefore " be a great stride forward in removing from the mine one of the principal dangers to health and safety that has existed for too long." The progress of the experiment will be watched by all engineers with interest and we may look forward to further reports on its widespread development.

[1] THE MINING MAGAZINE, Nov., 1950; Sept., 1953; Feb., 1955; Apr., 1957.

[2] BROWN, W. B. Reports of H.M. Inspectors of Mines for 1956: East Midland Division. London: H.M. Stationery Office. Price 3s.

Cornish Mining Development Association

The annual report of the Cornish Mining Development Association to be presented at the annual meeting in Camborne on April 18 once again makes reference to the Government's apparent continued indifference to the welfare of the metalliferous mining industry in this country, but expresses the hope that the symposium arranged for September next by the Institution of Mining and Metallurgy in conjunction with the United Kingdom Metal Mining Association may be successful in giving wider publicity to the industry's legitimate claims. The Association feels that in present conditions there is little incentive at present to encourage risk capital to undertake prospecting and development in the United Kingdom, but it hopes that there may yet be a change of " climate."

Note is taken by the Association of the fact that since 1918 there have been several investigations of the country's mineral potential and that successive Governments have certainly not lacked expert advice as to the feasibility and advisability of reviving the mining industry. All such advice has, however, been ignored, it is felt, at a time when other governments are doing much to encourage their own mining industries. Public opinion in Britain is at present, it is realized, as ill-informed and indifferent to the importance of having a healthy mining industry here as is Government and until something is done to change that " it is difficult to see how any worthwhile progress can be made." The Association feels that other industries here and abroad have proved the vital importance of " public relations " and says that unless the mining industry in Britain makes use of that extremely potent weapon it would seem that it will only have itself to thank for its continuing stagnation and ultimate extinction.

MONTHLY REVIEW

Introduction.—The setback in American business may, it is feared, yet affect affairs in the Commonwealth, although commodity prices remain steady at the lower levels reached a month ago. As regards base metals copper is now considered much sounder statistically and any new demand is likely rapidly to steady confidence in the market.

Transvaal.—Following the annual meeting of VAN DYK CONSOLIDATED MINES to be held in Johannesburg next month consideration is to be given to reducing the capital of the company from £2,489,400 to £2,143,650, such reduction to be effected by returning to members 1s. 3d. per share.

The report of BRAKPAN MINES for 1957 shows a profit of £270,586 and an available total of £640,912, of which dividends equal to 9d. a share require £172,500. In the year 1,354,000 tons of ore treated yielded 220,794 oz. of gold. At December 31 last the ore reserves were estimated as 2,366,900 tons averaging 4·99 dwt. in value over 50·98 in.

SPRINGS MINES reports a profit of £137,296 for 1957, the accounts showing £582,060 available, of which a dividend equal to 4½d. a share absorbed £189,563. The mill treated 1,510,000 tons of ore in the year and recovered 167,371 oz. of gold. At December 31 last the ore reserves were estimated as 1,965,000 tons averaging 4·29 dwt. over 42·52 in. Shareholders are reminded that the margin of working profit is very small and that with all major development now completed the greater part of the advance during the year was of a secondary nature, for the splitting of blocks of payable ore and for redevelopment through faulted areas in preparation for stoping.

The operations of RANDFONTEIN ESTATES GOLD MINING in 1957 resulted in a profit of £1,637,39?, dividends equal to 4s. 6d. a share requiring £914,300 of the £1,665,753 available and uranium loan payments £622,135. In the year 2,347,246 tons of ore was milled and 234,077 oz. of gold and 1,666,001 lb. of uranium oxide recovered. The ore reserves at December 31 last include 537,000 tons averaging 4·5 dwt. in gold and 1,550,000 tons averaging 1·2 lb. uranium oxide and 1·8 dwt. in gold.

GOVERNMENT GOLD MINING AREAS reports a profit of £281,997 for 1957, the accounts showing £492,269 available, of which, after various allowances, £408,407 was carried forward. In the year 1,077,000 tons of ore milled yielded 174,350 oz. of gold, while 1,730,600 tons of slimes yielded 152,163 tons of pyrite concentrates. Ore reserves at December 31 last are given as 662,000 tons averaging 5·7 dwt. over 67 in. Following the annual meeting in Johannesburg next month it is to be proposed that the company's capital be reduced to £1,120,000 by a return of 6d. a share.

The operations of NEW STATE AREAS in 1957 resulted in a profit of £15,752. With the sum brought in and other items there was £138,058 available, of which after allowances £69,838 is carried forward. Salvaging and the sale of equipment have continued during the year, during which 493 oz. of gold was recovered. Following the annual meeting next month a third return of 6d. a share is to be proposed, reducing the capital to £1,173,378 13s. 6d.

The report of EAST CHAMP D'OR GOLD MINING for 1957 shows a profit of £65,271 and £86,707 available, of which dividends totalling 7d. a share require £60,637. The mill crushed 143,000 tons of ore in 1957 and recovered 4,176 oz. of gold and 116,853 lb. of uranium oxide. Ore reserves are given as 167,000 tons averaging 1·0 dwt. in gold and 1·1 lb. of uranium oxide.

The accounts of ROSE DEEP for 1957 show a profit of £58,253 and £316,987 available, of which after various allowances £293,244 is carried forward. The 610,000 tons of ore milled in the year yielded 91,724 oz. of gold. Ore reserves at December 31 last are given as 423,000 tons averaging 4·3 dwt. over 53·9 in. Following the annual meeting next month it is to be proposed that the capital of the company be reduced to £227,500 by a return of 3s. a share.

NEW KLEINFONTEIN suffered a loss of £33,445 in 1957, the accounts showing a credit balance of £186,327 carried forward. The mill crushed 1,172,000 tons of ore in the year and recovered 140,058 oz. of gold. Ore reserves at December 31 last are given as 1,624,000 tons averaging 3·3 dwt. in value over 44 in. The report states that in the

year under review an approach was made to BRAKPAN MINES with a view to arranging a tribute arrangement regarding certain claims along the common boundary between the two properties.

The report of SPAARWATER GOLD MINING for 1957 shows a profit of £8,980 and a credit balance of £151,922 carried forward. In the year 38,845 oz. of gold was recovered from 126,600 tons of ore milled.

At the annual meeting of the MESSINA (TRANSVAAL) DEVELOPMENT COMPANY held in Johannesburg last month the chairman was able to assure shareholders that in spite of the present price of copper operations at the property are still being carried on at a profit.

With the recent dividend notice shareholders of the UNION CORPORATION were informed that operations in 1957 had resulted in a profit of £1,578,431. It was later announced that to provide additional finance for its business (including the further exploitation of the Kinross goldfield) the Corporation has arranged to issue £2,000,000 of unsecured 6½% notes at par, repayable in instalments in 1974–1983. They have been privately placed in the Union of South Africa.

At the annual meeting of NIGEL GOLD MINING to be held in Johannesburg next month shareholders will be asked to approve a reduction in capital to £215,890 7s. by a return of 2s. a share.

Orange Free State.—Last month PRESIDENT BRAND GOLD MINING announced that the Basal Reef was intersected in the No. 2 sub-vertical shaft at a depth of 972 ft. below the collar on 46 level. A complete exposure was obtained and 16 sections were sampled, all of which proved payable, averaging 14·54 dwt. over 43·38 in. The uranium oxide value was 34·27 in.-lb.

FREE STATE SAAIPLAAS GOLD MINING announced recently that additional finance is required to proceed towards production at as early a date and as efficiently as possible. Accordingly it is proposed to raise in the near future the sum of £4,854,046 by an offer of combined units of shares and convertible notes.

FREDDIES CONSOLIDATED MINES reports a profit of £120,819 for 1957, which reduces the accumulated loss brought in to £888,046. In the year 665,000 tons of ore was milled and 192,165 oz. of gold recovered, while 208,217 lb. of uranium oxide was apportioned the company from slimes re-treatment. Ore reserves at the end of 1957 were estimated as 1,292,000 tons averaging 5·6 dwt. in gold with 13·6 in.-lb. of uranium oxide.

Diamonds.—Earlier this month it was announced that diamond sales through the Central Selling Organization totalled £15,289,981 in the three months to March 31 last, £10,513,699 of this amount representing gem stones.

South-West Africa.—The operations of the SOUTH WEST AFRICA COMPANY in the year to June 30 last, when mineral products realizing £1,242,078 were sold, resulted in a profit of £2,465, the accounts showing a credit balance of £15,773 carried forward.

Southern Rhodesia.—Last month shareholders of the WANKIE COLLIERY COMPANY were informed that it had been decided to place No. 1 colliery on a caretaking basis. This action, it is stated, follows a careful study by the company of future coal demand in the Federation, which indicates that further expansion is unlikely in the foreseeable future. The company's three pits are currently equipped to produce over 5,500,000 tons a year, but an output above 4,250,000 tons a year has not been called for. The company hopes that the measure it has adopted will assist in stabilizing the selling price of coal in the Federation.

Northern Rhodesia.—With the recent dividend notice shareholders of the RHODESIA BROKEN HILL DEVELOPMENT COMPANY were informed that the operating profit for 1957, after providing for taxation, was £909,219, which compares with £1,342,745 for the previous year.

At the extraordinary meeting of BANCROFT MINES held in Salisbury on April 2 a special resolution was passed increasing the authorized capital of the company from £6,250,000 to £13,750,000 by the creation of 7,500,000 6½% redeemable participating preference shares of £1 each. In terms of an ordinary resolution these shares have been placed at the disposal of the directors.

Earlier this month shareholders of RHODESIAN ANGLO AMERICAN were informed that of the £4,000,000 6% registered loan stock recently offered to members acceptances and excess applications, together with the £500,000 subscribed in London, totalled approximately 63·5%. (The amount offered in London was limited to £500,000 by the terms of the Capital Issues Committee's consent to the issue.) The ANGLO AMERICAN CORPORATION OF SOUTH AFRICA, as underwriter, has subscribed for the remainder

of the issue amounting to approximately 36·5 %.

Ghana.—Following the annual meeting of ARISTON GOLD MINES held in London earlier this month shareholders were told by Mr. C. J. Burns, recently returned from Ghana, that the Government had shown that it is fully aware of the difficulties experienced by low-grade mines in terms of fixed price for gold and had done all in its power to alleviate difficulties. In July, 1956, a grant of £200,000 to the marginal mines was made to cover the period from June, 1956, to July, 1958. The Government has now undertaken to bring out to Ghana an independent mining expert who will report on the state of the gold-mining industry, with a view to the passing of new legislation granting a subsidy to marginal or low-grade mines on the lines of similar legislation enacted both in Canada and Australia.

Shareholders of the ASHANTI GOLDFIELDS CORPORATION were informed at the recent annual meeting that it is planned to convert to skip hoisting in the Eaton-Turner shaft in August next, using the full winding speed of 2,000 ft. per minute. At present mainly waste and development rock is being handled, but from August onwards important tonnages of high-grade ore would be hoisted.

Nigeria.—Last month the directors of NARAGUTA KARAMA AREAS announced that they had received an intimation from the BISICHI TIN COMPANY (NIGERIA), LTD., to the effect that they are prepared to purchase the whole of the issued share capital of Naraguta Karama. Negotiations are proceeding, it was stated.

In April the provisional price of columbite for royalty purposes has been fixed at 180s. a unit.

Tanganyika.—At a meeting of holders of the unsecured loan stock of URUWIRA MINERALS, LTD., to be convened it will be proposed that half-yearly interest payments shall be suspended in respect of the current year. In view of the fall in metal prices and in the grade of ore being mined the company is at present unable to fulfil its obligations to its two principal and secured creditors—the Tanganyika Government and the United States.

Australia.—Last month PARINGA MINING AND EXPLORATION announced that their consultants had been informed that a contract for diamond drilling was signed on March 7 and drilling was soon to start. Shaft sinking continued satisfactorily, it is stated, by the end of February a depth of 104 ft. having been reached, where encouraging results were encountered.

In a report issued by PLACER DEVELOPMENT, LTD., it is announced that the dry separation plant on the heavy mineral sand project of CLUTHA DEVELOPMENT, LTD., at Harrington, New South Wales, was completed and production tests are being carried out with a view to ascertaining maximum performance of the plant. On February 11, 1958, it is stated, the Joint Coal Board and the Federal Government of Australia publicly announced the sale of Foybrook-Newdell coal ventures to Clutha Development. Plans are being made for the further development of the coal mine and future marketing of the coal.

New Guinea.—In the three months to November 30 last BULOLO GOLD DREDGING treated 1,793,400 cu. yd. of ground and recovered 9,192 oz. of gold. One dredge only, No. 5, was operating in the period.

Malaya.—Last month UNITED PATANI (MALAYA) RUBBER ESTATES announced that they had received a report from the mining expert who went to Malaya as a result of the offer from a syndicate seeking prospecting rights in an area of about 300 acres which it believed to contain a rich deposit of iron ore. The report shows that although the deposits appear to be substantial they are not such as to make it desirable for United Patani to mine the ore on their own account. Accordingly heads of agreement have been reached with the syndicate, which has considerable iron-mining interests, enabling it to prospect the area for a period of six months and providing for a tribute to be paid of $1·50 per ton of any iron ore mined and shipped.

With the recent dividend notice shareholders of SELAYANG TIN DREDGING were informed that the profit for the year to September 30 last, after charging depreciation, was £18,457.

At an extraordinary meeting of PENGKALEN, LTD., to be held on April 24 it is to be proposed that all preferred shares be converted to ordinaries in order to simplify the company's capital structure.

Burma.—In the six months to December 31 last the BURMA CORPORATION (1951) treated 29,302 tons of ore and produced 6,209 tons of refined lead, 99 tons of antimonial lead, 559,592 oz. of silver, 132 tons of copper matte, 135 tons of nickel speiss, and 8,209 tons of zinc concentrates. BURMA MINES, LTD., with

its recent dividend notice, reports a profit of £129,459 for 1957.

Colombia. — PATO CONSOLIDATED GOLD DREDGING reports a profit of $1,200,000 for 1957, subject to audit. In the December quarter 6,256,000 cu. yd. of ground was dredged and 32,869 oz. of gold recovered.

British Guiana.—In 1957 British Guiana produced 16,490 oz. of gold and 241,864 diamonds weighing 29,037 metric carats.

Brazil.—Last month shareholders of ST. JOHN D'EL REY GOLD MINING were informed that the council of the SUMOC (Superintendency of Money and Credit) had decided to grant emergency financial assistance for the gold-mining industry in Brazil until June 30, with a possibility of extension for a further period of six months. The company hopes that operations will be continued without incurring further operating losses in Brazil so long as the measures continue in force. At the same time stockholders are advised that no profit margin can be expected. It has already been announced that the HANNA COAL AND ORE CORPORATION has acquired, together with Mr. Leo Model and associates, the controlling interest in the company.

Canada.—The accounts of ALUMINIUM, LTD., for 1957 show a net income of $41,422,456, or $1·67 per share, as compared with $55,657,372, or $1·85 per share, in the previous year. The report states that in addition to the protracted strike at the Aluminum Co. of Canada's Arvida smelter conditions in the industry changed in the year. Whereas the preceding ten years were, with few exceptions, years of strong demand, full production, and rapid expansion free-world production did not increase in 1957, for, while consumption in Europe and many other areas continued to grow, overall consumption dropped by about 3%.

United Kingdom.—HALKYN DISTRICT UNITED MINES has announced a profit of £3,024 for 1957 and a credit balance of £49,483 carried forward. It had been stated earlier that lead mining at Halkyn had become unprofitable at the present low level of metal prices and that operations in the lead mines were to be suspended on April 18. It is the intention to resume operations as soon as improved economic conditions permit.

Rio Tinto Company.—With the recent dividend notice shareholders of the Rio Tinto Company were informed that the profit for 1957, subject to audit and excluding the accounts of the RIO TINTO MINING CO. OF CANADA and its subsidiaries, was £1,750,000.

DIVIDENDS DECLARED

* Interim † Final

(Less Tax unless otherwise stated.)

†**African and European Investment Co.**—3s., payable May 16.

†**Anglo American Corporation of South Africa.**—6s., payable May 16.

Apex Mines.—Pref. 2¾%, payable May 12.

†**Blinkpoort Gold Syndicate.**—1s. 3d., payable May 20.

†**British Alumunium.**—8%, payable May 20.

†**Burma Mines.**—1¾d., free of tax, payable May 14.

Consolidated Tin Smelters.—Pref. 3½%, payable May 10.

†**De Beers Consolidated Mines.**—6s., payable May 16.

De Beers Industrial Corporation.—Pref. 2¾%, payable May 16.

***Free State Geduld Mines.**—2s., payable May 20.

***General Tin Investments.**—4%, payable May 2.

†**Globe and Phoenix Gold Mining.**—10%

***Great Boulder Gold Mines.**—9d. Aust., payable May 7.

***Harmony Gold Mining Co.**—1s., payable May 20.

†**Heawood Tin and Rubber Estate.**—15% and 5% bonus, payable May 16.

***Nigerian Electricity Supply Corporation.**—4%.

***President Brand Gold Mining Co.**—2s. 6d., payable May 20.

***President Steyn Gold Mining Co.**—1s. 3., payable May 20.

†**Rhodesia Broken Hill Development Co.**—11·2d., payable May 16.

†**Rio Tinto Co.**—26%, payable June 5.

***St. Helena Gold Mines.**—1s., payable May 20.

†**Selayang Tin Dredging.**—20%, payable May 6.

†**Union Corporation.**—2s.

†**Union Minière du Haut-Katanga.**—Ord. Fr. Belge 1,500.

***Wankie Colliery.**—6d., payable May 30.

***Welkom Gold Mining Co.**—3d., payable May 20.

***Western Holdings.**—3s., payable May 20.

†**Willoughby's Consolidated.**—10%.

METAL PRICES

April 9.

Aluminium, Antimony, and Nickel per long ton; Chromium per lb.; Platinum per standard oz.; Gold and Silver per fine oz.; Wolfram per unit.

	£	s.	d.
Aluminium (Home)	180	0	0
Antimony (Eng. 99%)	190	0	0
Chromium (98%–99%)		7	2
Nickel (Home)	600	0	0
Platinum (Refined)	26	15	0
Silver		6	4
Gold	12	9	2½
Wolfram (U.K.)		—	
(World)	4	10	0

Tin
Copper
Lead
Zinc
See Table, p. 240

Flame and Allied Tests for Minerals in Review

K. F. G. Hosking, Ph.D., A.M.I.M.M.

An appraisal
designed to
fill a gap
in the literature

Abstract

In the accompanying review—which is written to fill an obvious gap in the literature—the following tests are described and their merits appraised: Classical flame tests; flame tests for tin, gold, and bismuth; tests depending on the luminescence of the hydrogen flame; electric-arc tests and micro-chemical flame analysis.

Flame tests are of great value to the mineralogist, yet no textbook—as far as the writer is aware—deals comprehensively with them. This fact in his view justifies the present article.

Classical Flame Tests

The expression " classical flame tests " is used here to denote those tests which appear in practically all accounts of blowpipe analysis. Essentially the method consists of picking up a little of the powdered sample on the end of a platinum or iron wire or magnesia flame stick, previously damped with concentrated HCl, and holding it in a flame—preferably a non-luminous one. Volatile compounds of certain elements are thus liberated which impart a characteristic colour to the flame.

Alternatively, a good flame coloration may often be obtained by dipping a fragment of the mineral in question, held in forceps, in concentrated HCl and then holding it in a suitable flame. Furthermore, dust generated by scratching a mineral vigorously with a penknife in the near vicinity of a flame is often capable of imparting a diagnostic colour to the latter.

By placing the sample-charged wire or rod first in a cool and then in a hot part of the flame colorations due to more than one element may be detected. Thus, as potassium chloride is more volatile than the chlorides of the alkaline earths, it is possible to detect first potassium and then an alkaline earth when they are both present.

Examination of flame colours through coloured glass and celluloid filters often assists diagnosis. A cobalt or, better, didymium glass filter is generally used to detect the potassium flame in the presence of the masking sodium flame. The Merwin screen, another device, is composed of two strips of celluloid—one blue and the other violet—which partly overlap so that three filters are available. This screen is of considerable assistance when examining flames, chiefly because it enables the potassium flame to be identified in the presence of the sodium and permits certain differentiation to be made between the calcium and strontium flames. It does not, however, facilitate differentiation between the similar lithium and strontium flames, but, with experience, it is possible to distinguish between them by employing a green glass filter (Winchell, 1942, p. 200). Winchell (1942, p. 200),[1] having decided that a given red flame is either due to strontium or lithium, differentiates between the two by testing the ignited residue on the wire for alkalinity. The strontium residue—unlike that of lithium—is alkaline. Smith (1953, pp. 62–4) differentiates between the two flames in question by adding barium chloride to the test substance. The lithium flame appears *before*, and the strontium flame *after*, that due to barium.

Vogel (1947, p. 108) is of the opinion that " the only trustworthy way to employ flame tests in analysis is to resolve the light into its component tints and to identify the cations present by their characteristic set of tints." For routine tests he suggests that this is best accomplished by means of a direct-vision spectroscope, but he limits the general use of this piece of apparatus to the detection of sodium, potassium, lithium, and thallium. It is, in his opinion, of less value for the detection of the alkaline earths as their spectra are comparatively complex. The present writer, in common with most mineralogists, is of the opinion that trustworthy results can usually be obtained from flame tests without employing a spectroscope, although it is most useful for analysing " mixed " flames. In Dana's *Manual of*

[1] A list of references is given at the end of this article.

Mineralogy, 15th edition, p. 107, a "home-made" diffraction spectroscope is described which is suitable for simple qualitative work.

Flame Tests Employing Different Reagents and/or Techniques

It is necessary to use techniques and/or reagents differing from those described above in order to obtain satisfactory flame colorations when testing certain refractory minerals. Furthermore, certain elements whose chlorides do not impart a characteristic colour to the flame may be detected by flame tests in which compounds other than chlorides are used. The majority of these special flame tests are briefly described below in order to indicate the range of methods used.

Tests for Lithium, Sodium, and Potassium in Silicates

Usually silicates containing lithium, sodium, or potassium do not give characteristic flame colorations when heated alone or in the presence of hydrochloric acid in the flame of a bunsen burner or an alcohol lamp. In such cases Dana (1932, p. 364) recommends carrying out the test on a 1 : 1 mixture of powdered sample and gypsum which is introduced into the flame on a damped platinum wire. Beringer (1931, p. 217) uses Turner's Flux (a mixture of 4·5 parts of potassium bisulphate and 1 part of fluorite) instead of gypsum when testing for lithium or sodium. For obvious reasons it cannot be employed when testing for potassium. Recently MacKay and Brown (1955, p. 186) have suggested that lithium can be most effectively identified in minerals in the field by subjecting them to the intense heat of a "Prestolite" (acetylene) torch and examining the flame either through didymium glass or by means of a hand spectroscope.

Tests for Borates and Phosphates

If the more soluble borates and most phosphates are damped with sulphuric acid and introduced into a flame the latter is coloured a characteristic green. The more refractory boron-containing minerals—for example, tourmaline—do not so react. However, the characteristic flame coloration may be obtained from all borates and phosphates by employing Turner's Flux in the manner noted above.

Low, Weinig, and Schoder (1945, p. 10) test all refractory minerals suspected of containing appreciable amounts of boron as follows: A little of the powdered sample is fused with sodium hydroxide in a silver loop. The product is crushed and warmed with a little methanol and HCl and the vapours thus produced are introduced into a colourless flame. In the presence of boron the flame is coloured green.

Tests for the Chloride Ion

To test for the chloride ion McGrigor (1915, p. 63) prepares a bead of microcosmic salt on a platinum wire and fuses a little cupric oxide into it until the flame of copper ceases to appear. A little of the sample is taken up on the bead which is then introduced into a colourless flame. In the presence of chloride ion the flame becomes azure blue.

Bromides similarly treated colour the flame bright blue with green streaks and iodides colour the flame green (McGrigor, 1915, pp. 62 and 67).

Flame Tests Applicable to the Naturally Occurring Sulphates of the Alkaline Earths

These minerals do not readily give good flame colorations when subjected to the normal test. However, an adequate coloration is usually obtained if the mineral under examination is first partially converted to sulphide by heating it before the reducing flame of the blowpipe and the product subjected to the usual flame test.

Alternatively, good flame colorations may be obtained by mixing any of the minerals under discussion with a little silver chloride paste, taking up the mixture on an iron wire, and introducing it into the flame. The reagent is a good one to use in flame tests generally (excepting when testing for phosphates, chlorides, or borates) as it prolongs the duration of the flame colour.

Flame Tests for Tin, Gold, and Bismuth

Hydrogen, which is generated from the reaction between zinc and hydrochloric acid in the presence of any soluble and most insoluble tin compounds, imparts a blue colour to the non-luminous flame of a Bunsen burner. This constitutes a selective test for tin and the reaction only fails when arsenic is present in amounts equal to or greater than that of the tin. To show the presence of tin in cassiterite by this method it is necessary to fuse the mineral with fusion mixture and carry out the test on the resultant product.

Usually the test substance and reagents are placed in a porcelain dish and stirred with a test-tube half filled with cold water, after which the bottom of the tube is introduced

into the flame. The presence of tin is indicated by the appearance of a blue mantle around the glass.

A similar test for tin in which coal-gas is used instead of hydrogen is conducted as follows: A drop of the test solution is placed on a magnesia stick and evaporated to dryness by holding it near to a flame. The area occupied by the test substance is damped with a drop of concentrated HCl and placed in the reducing zone of the flame from a microburner. The development of a blue flame mantle indicates tin.

The above tests, which have been developed and investigated by Feigl and others (see Feigl, F., 1947, p. 88), are based on the earlier researches of Meissner (1930, p. 247), and the test-tube method noted has been employed by the Russians to obtain semi-quantitative data concerning the distribution of cassiterite in alluvial deposits (Sokoloff and Hawkes, 1950, pp. 65–6).

Mehrotra (1948, p. 321) reports that when a solution of a gold salt is subjected to the above tests a brilliant green mantle forms. He also states that copper interferes and, in the presence of tin, the green mantle is masked by the blue tin mantle.

In the absence of tin, arsenic, copper, and gold, bismuth ions cause a transient greenish-blue mantle to develop which is most evident when the magnesia stick method of testing is employed.

Tests Depending on the Luminescence of the Hydrogen Flame

Extremely small quantities of bismuth, antimony, and manganese may be detected by mixing the sample with calcium carbonate and placing the mixture in a hydrogen flame. Colours of diagnostic value are imparted to the flame at the moment when the mixture, containing any of the three elements noted above, is introduced. Bismuth imparts a transient cornflower blue, antimony a blue-green, and manganese a yellow colour. (See Feigl, 1947, pp. 62 and 86, and Donau, 1913, p. 949.)

An almost identical method has been described by Neunhoeffer (1951, pp. 91–4) for detecting certain of the rare earths. The rare earth is precipitated together with a large excess of calcium carbonate and is eventually ignited. When the ignited mixture is placed at the edge of a hydrogen flame the rare earths activate the calcium oxide to luminescence and the colours produced by various members of the group are as follows:

Table 1

Colours Imparted to an Electric Arc

(After Peterson, Kauffman, and Jaffe, 1947, p. 332.)

Element	*Colour on positioning screen or other characteristics*
Al	Greenish-blue.
Sb	White fumes.
As	Garlic odour.
Ba	Green.
Be	Greenish-blue.
B	Green.
Ca	Orange.
CaF_2	Canary-yellow.
Cb	Blue with red fringe. Pitted lower electrode and white oxide coating.
Cr	Green.
Cs	Bluish-white.
Cu	Green.
Fe	Blue with yellowish-white fringe. Sparks and popping bead.
Li	Red.
Mg	Green.
Mo	Blue metallic coating on lower electrode.
Nd	Light orange-red.
K	Bluish-white.
Pr	Greenish-gray.
Sc	Light orange.
Sm	Red.
Ag	Green.
Na	Yellow.
Sr	Red.
Ta	Blue with a red fringe. Pitting on lower electrode and white oxide coating.
Tl	Green (very intense).
Ti	White.
U	Bluish-white.
W	Blue when current is reduced. Pitting of lower electrode and yellow oxide coating.
Y	Red.
Zr	White flashes.

Ytterbium, pale blue-violet; lanthanum, brick-red; cerium, yellowish-green; praseodymium, red; neodymium, orange-red; samarium, yellowish-green; dysprosium, pale green; thulium, yellowish-green.

As most rare-earth minerals usually contain several rare earths this test is not likely to be of great value to the mineralogist excepting when conducting prolonged specialist studies.

Electric Arc Tests

Peterson, Kauffman, and Jaffe (1947, pp. 322–335), describing the rapid identification of many elements occurring in minerals by utilizing a Bunsen-type spectroscope to examine the spectra produced when samples are arced between graphite electrodes, state that (p. 331) " many elements when present in major amounts can be quickly identified *without* a spectroscope through recognition of

the colours they impart to the arc. They will be imaged on the test screen in the form of a halo surrounding the centre portion of the arc." The colours due to various elements are noted in Table 1. Although many of the elements produce either red or green tints the authors state that with practice the halo due to any given element noted in Table 1 can be distinguished from all others! An earlier detailed study of the use of arc images in chemical analysis has been conducted by Mott (1920).

It would appear that this aid to mineral identification would be well worthwhile using in a laboratory even if the entire assembly for spectroscopic analysis were not available and in this connexion it is relevant to state that the nature of the fusion products on the electrodes are often additional aids to mineral identification.

Micro-Chemical Flame Analysis

Geilman and Isermeyer (1950, pp. 249–262) have made the classical flame reactions the basis of a scheme for the detection of traces of a number of volatile elements. Oxide, metal, and halide sublimates are deposited on the base of a silica test-tube filled with cold water. The colour of the sublimate is noted, if the latter is sufficiently strongly developed, after which the film is dissolved in a suitable reagent and the resultant solution is examined for the presence of "likely" elements by micro-chemical means.

The flame in which the sublimations are conducted is obtained by using a mouth blowpipe as a burner and the gas is so adjusted that the flame is from 20 mm. to 25 mm. high. The hole from which the gas emerges should be such that the flame is slim and sharp and has a slightly luminous tip. During the actual test period the blowpipe is adjusted so that the luminous tip *just* touches the base of the water-filled tube. If this adjustment is made correctly the sublimate will occupy a circle of from 2 mm. to 3 mm. diameter.

Production of Oxide and Metal Sublimates

In order to obtain oxide or metal sublimates a piece of high-grade asbestos string 2 mm. to 3 mm. long and from 0·3 mm. to 0·5 mm. thick is damped and tapered by twisting between the fingers. Holding the taper in tweezers, the extreme tip is cut off. Three to five mg. of the test substance is taken up on the end of the damp taper and the sample area is dried by holding it near the flame. When the sample is dry the water-filled tube is placed in position and the taper is held in the fusion zone of the flame. Adequate sublimates of the more volatile elements—*e.g.*, tellurium, zinc, cadmium, and antimony—are obtained after 15 seconds' heating, but elements such as lead, bismuth, thallium, and tin require 30 seconds for a reasonable quantity of sublimate to accumulate.

Throughout every test the colour of the flame is noted.

Modifications of the Normal Technique

If it is suspected that the element sought occurs in very small quantity in the test material several portions of the sample are heated, but all the sublimates are collected on one tube.

By altering the flame position during a given test so that two or more spots of sublimate are obtained, a partial separation of the very volatile from the less volatile elements may be effected. Such a separation is, however, very imperfect because the flame is so hot that the temperature of the small sample rises very rapidly.

If the substance sought is not extremely volatile and is associated with a large quantity of very volatile material—such as, arsenious oxide or mercuric sulphide—it is wise to remove the latter by placing 0·05 g. to 0·1 g. of the sample in an ignition tube and heating it at the lowest temperature necessary to sublime the more volatile fraction. The residue is then tested in the normal way, but if it is small it is advisable for ease of handling to mix it first with an indifferent substance such as aluminium oxide.

Should it be necessary to test for a very small quantity of readily volatile material in a large excess of much less volatile substance—*e.g.*, traces of mercuric sulphide in zinc sulphide—it is best to place 0·05 g. to 0·1 g. of the sample in an ignition tube over which is then placed another ignition tube and to drive the easily volatile material into the covering tube by the application of the minimum amount of heat. This sublimate is then examined by the appropriate micro-chemical methods.

Production of Halide Sublimates

Tests depending on the production of halide sublimates are not as sensitive as those in which metals and oxides are sublimed. They are, however, especially useful for identifying copper, silver, and nickel in samples after the more readily volatile components have been removed.

To produce a halide sublimate a portion

Table 2

Characteristics on Sublimates

(Based on descriptions by Geilman and Isermeyer, 1950.)

Element	*Type of Sublimate*				
	Metal	*Oxide*	*Chloride*	*Bromide*	*Iodide*
Sb	Brownish	White	—	—	Yellow
As	Brown-black	White	—	—	Yellow
Pb	Brown	Yellow	—	—	Yellow
Cd	Black (+ brown oxide edge)	Brown	White	White	White
Ge	—	Black-brown or white	—	—	—
In	Black (+ brown edge)	Yellow	White	Yellowish	Brown-yellow
Mo	—	Yellow + blue	—	—	—
Ni	—	—	←Greenish-white→		
Hg	Black-grey	—	←Grey-white→		→Yellow(± red)
	Sulphides and selenides of mercury give direct red sublimates				
Re	—	Yellow (+ blue edge)	—	—	—
Ag	—	—	White	←Yellowish→	
Se	Black (+ red edge)	White	—	—	—
Te	Black (+ brown edge)	White to yellowish	—	—	—
Th	Black-brown	White-yellow	White	Yellowish	Red-yellow
Bi	Black (+ brown edge)	Yellow-white	White	Yellowish	Brown-red
Zn	Black (+ brown edge)	White	←Colourless and hygroscopic→		
Sn	Black (+ brown edge)	White	—	—	—

of the test substance is fused with borax on a piece of platinum wire of 0·1 mm. to 0·2 mm. diameter so that a bead of from 2 mm. to 3 mm. diameter is produced. A small crystal of alkali metal halide (Cl^-, Br^-, or I^-) is added to the molten bead which is then placed in the oxidizing zone of the flame. The sublimate is collected on a water-filled tube.

Examination of Sublimates

Having prepared the sublimate of metal, oxide, or halide, it is examined visually and then brought into solution on a microscope slide in order that the elements present may be determined by micro-chemical means. Sometimes the sublimate is so slight as to be invisible, but it will give positive results when subjected to suitable micro-chemical tests.

The solvents employed for attacking a given sublimate depend on its composition. The attacking agents recommended by the originators of the method are (p. 256) :—

(1) 20% HNO_3 for Pb, Bi, Se, Te, Hg, and Tl.

(2) 20% HCl for Zn and Cd.

(3) 1 volume of 20% HCl + 1 volume of 30% H_2O_2 for Sn, Sb, Te, and Se.

(4) 1 volume of NH_4OH + 1 volume of 20% H_2O_2 for As, As_2O_3, MoO_3, Re_2O_7, and GeO.

(5) Water + a little HCl or HNO_3 for all iodide sublimates.

(6) Concentrated HCl or NH_4OH for AgCl.

The appearance of the sublimates is summarized in Table 2. For information concerning the micro-chemical tests advocated by the authors the original paper should be consulted, but the present writer has found that the more accessible tests of Short (1940) are generally quite adequate for the purpose under discussion.

Practical Applications of the Method

The method is of value in that it permits of the rapid identification of minor constituents of small samples of minerals without resorting either to complex chemical methods or to physical methods entailing the use of costly apparatus.

By using the above techniques the originators have, for example, demonstrated the presence of small amounts—0·05% and less—of arsenic, lead, and zinc in pyrite and of 0·05% of copper in limonite.

It is possible to identify elements when they occur in much smaller amounts than those noted above by first concentrating them.

Concentration is achieved by bringing a comparatively large quantity of the sample—one gram. or more—into solution and co-precipitating the elements sought with a "trace-catcher." The resulting precipitate is collected by centrifuging, washed with water then with acetone, and dried. Finally it is treated in the manner noted earlier in order to obtain a sublimate which is examined by micro-chemical means. Thus, the presence of cadmium and lead in a zinc salt containing 0·001% and 0·008% of these elements respectively was shown by co-precipitating their sulphides and cupric sulphide and examining the product in the manner described above.

As the method is both interesting and useful, and as no account in English has hitherto appeared, the writer feels justified in having discussed it at some length.

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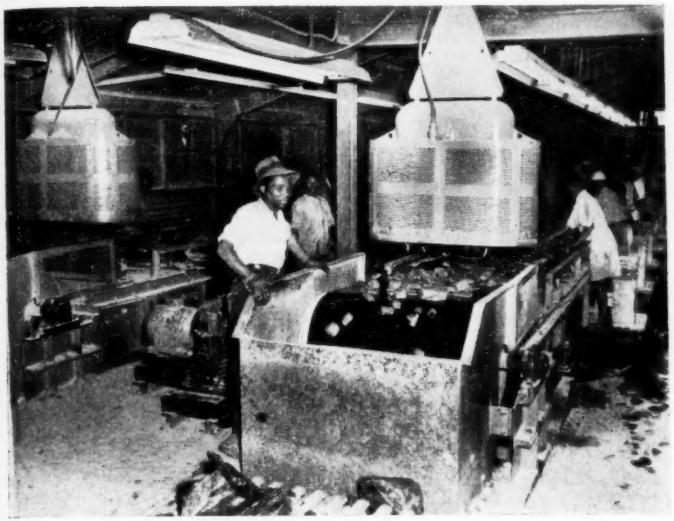
South African Mining in 1957

L. A. Waspe

The industry begins to benefit from the various programmes designed to improve labour efficiency

Introduction

Provisional returns of the labour complement of the South African mining industry are not yet available, but in gold-uranium operations the European labour shortage persisted and appeared to be greater on the Free State mines, especially in the artisan staff. However, 1957 saw a reduced overall demand on the country's man-power to an extent rendering possible the suspension of recruiting artisans overseas, while recruiting of trainees for the mining schools has more recently been confined largely to Holland and Italy and to a less extent to Western Germany. Domestic recruiting has been intensified generally, although enrolment at the schools has remained below their capacity. The seasonal increase in the native labour complement over the early months of 1957 reflected slight advances on the corresponding 1956 figures, but the subsequent seasonal trend showed declines from the 1956 levels. To date the seasonal improvement in 1958 has been below the corresponding 1957 returns. According to the lastest available reports 62% of the gold-uranium native labour complement of the major mines have been recruited beyond



Magnets over Sorting Belts at Doornfontein.

the country's borders, a percentage that would have been higher but for restrictions on the part of the governments concerned.

In general the overall output *per capita* apparently again increased, due to improved training, greater efficiency, a better use and disposition of labour, and mechanization.

Supported by all interested parties a representative committee studied and has reported to the Government on the problems of the marginal mines, the prolongation of their operations, and/or staggering their closing to minimize unemployment and regional economic dislocation. The Government's desire is that these mines should be operated as long as possible in the national interest, even at the expense of profitability. The vulnerable mines are situated on the East, Central, and West Rand where many mines have scaled down operations to conserve labour, effect economies, and reduce or minimize working losses or maintain a measure of profitability, including the closing down of working sections, shafts, and plants in some cases. Such mines include Crown Mines, City Deep, Simmer and Jack, Robinson Deep, Consolidated Main Reef, Modderfontein East, and Rand Leases. Government Areas has given notice of the possible suspension of gold operations, but New Modderfontein, under new control, is to continue in work as a number of small producers.

Two factors are responsible for the contraction of gold output from the Witwatersrand—the exhaustion of ore, which neither a higher gold price nor reduced costs will ameliorate, and the rendering of large tonnages unpayable by increased costs, which in some cases would be relieved in only a few years by a higher gold price or reduced costs. Forms of assistance suggested have included State subsidies and/or extended rationalization of labour, including up-grading native staff for certain categories of work in order to reduce costs. The importance of the marginal mines is illustrated by relating the value of their output, which is roughly of the same order as what has been officially stated to be the country's requirements of overseas capital—namely, about £40,000,000 a year. The Government naturally wants to gain as much time before closures become widespread among the marginal mines for the establishment of alternative industries. On the other hand, break-up values of the companies concerned are thought to be becoming increasingly dependent on the application in extreme forms of the Group Areas Act, on Government policies regarding the establishment of additional industrial townships along the Witwatersrand in the immediate future, on housing policies and programmes, and on the establishment and/or transfer of industries near and in the native reserves.

The 1957 uptrend in costs arose partly from consolidation of cost-of-living allowances into the basic European wage structure, increased pneumoconiosis charges, and higher power costs and rail tariffs and

apparently to a less extent from conditions in individual mines and general economic trends.

Gold Production

The 1957 gold output again advanced to new record levels largely owing to the further expansion of operations by the new mines of the Free State and Klerksdorp fields and a further improvement in the grade of ore derived from improved beneficiation programmes involving extended sorting and/or in some cases the mining of higher-grade ore facilitated by the extension of underground operations. Most of these new mines as well as West Driefontein and Doornfontein have entered or are entering what can be described as the second phase of productive operations in programmes involving the sinking of additional hoisting and/or ventilation shafts, improving the ventilation flow otherwise (by winzes and/or refrigeration), extending stope faces, and expanding the milling rate. For the most part development ore still constituted an abnormally high proportion of the mill feed tonnage, but this can be expected to become normalized as operations approach the projected capacity rates with possible benefits reflected in the grade treated.

There do not appear to be many cases where the extension of operations may result in a marked downward adjustment of the mill grade to levels representative of the average mine grade, counterbalanced, however, by increased milling and the extent to which selective mining and beneficiation is or may be conducted. Western Holdings aims at an eventual milling rate of 150,000 tons a month; Free State Geduld at 125,000; President Brand at 125,000; President Steyn at 125,000, and Welkom at 125,000, while West Driefontein and Doornfontein are providing additional treatment capacities but eventually at a lower grade. St. Helena aims at 150,000 tons a month, depending on development results; Freddies Consolidated has the capacity to mill greater tonnages; Harmony is providing a treatment capacity of 135,000 tons a month, which may eventually be expanded to 180,000; Hartebeestfontein could mill about 110,000 tons a month; Virginia about 110,000; Buffelsfontein is providing a capacity of 150,000; Marievale about 90,000, and Vlakfontein will be able to mill slightly higher tonnages.

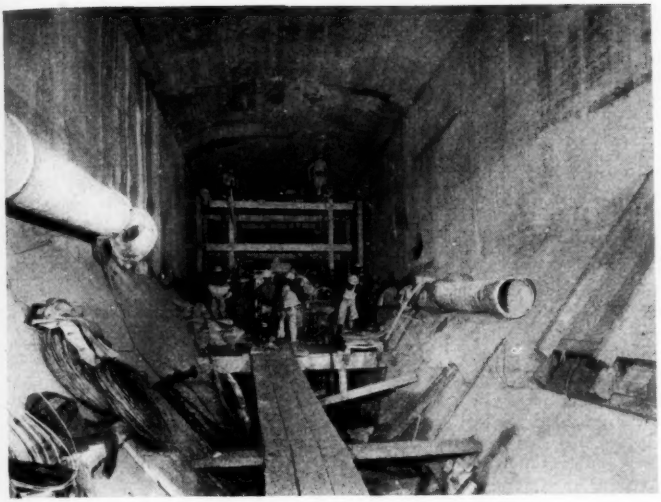
Among the developing mines, Winkelhaak will initiate production soon; Riebeeck possibly in 1959–60; Free State Saaiplaas (which achieved the world shaft-sinking rate of 834 ft. in a month in 1957) in 1960–61; followed by Western Deep Levels at milling rates to be raised from 100,000 tons to 200,000 tons a month with an average estimated yield of 10 dwt. to 12 dwt a ton. In the Bethal-Kinross area sufficient additional ground has been proved for two or three more mines. On the West Rand Johannesburg Consolidated Investment has proved a large tonnage in the Waterpan Block south of Randfontein. In the Klerksdorp area the Anglo-Transvaal group associated with, *inter alia*, New Pioneer (of the General Mining group) initiated drilling in a large area east of the Stilfontein/Hartebeestfontein/Buffelsfontein mine leases. On the East Rand South African Land and Exploration advanced exploratory development into its new Withok section with favourable preliminary results.

Technical

On the technical side the use of hydrocyclone classifiers was extended. Satisfactory performances were recorded in the use by Anglo American Free State mines of the Blair multi-rope stage hoist specifically designed for deep-level shaft-sinking. This equipment is being used in sinking the Western Deep Levels shafts. The first installation of the Blair multi-rope multi-layer double-drum hoist, which will be installed at Western Deep Levels, was effected at Western Reefs. This hoist is also specifically designed for deep-level shafts.

In the Free State the disposal of unpotable underground water (which has only very limited industrial uses) is still a serious problem. By 1960 about 30,000,000 gal. a day may have to be disposed of; the present method is by evaporation from large surface dams. However, demineralization by the electro-dialysis process has been highly successful and a large-scale treatment plant, which may be the forerunner of others, is being erected on the Free State Geduld mine.

Uranium oxide output in 1957 advanced further and while there may be a levelling-off this year a further increase is still expected. With the removal of security restrictions it was announced that the country's indicated ore reserves are 1,100,000,000 tons of ore with a content of about 370,000 tons of U_3O_8, equivalent to about 60 years of continuous



Settling Dam Construction at Driefontein.

output at the annual rate of 6,000 tons of oxide a year. Improved leaching has been effected by raising the pulp temperature in the leach tanks while improved gold recovery has resulted from extracting the uranium oxide first and then the gold, instead of *vice versa*.

Diamonds

Diamond output and the caratage sold declined last year but prices, especially of gems, were more than maintained owing to the continued keenness of demand and the overall inadequate output available, particularly of gems. Since the turn of the year, however, prices have eased slightly and, it is assumed, the demand also.

In 1957 the De Beers group extended diamond prospecting on the Namaqualand coast, Cape Province, where about 20,000 claims were scheduled for proclamation with extensions projected and prospecting initiated. Operations will be conducted on a Government lease with 40% of the profits *plus* ruling taxation of the balance accruing to the State. The group reported no important discoveries in the Tuli Block of Bechuanaland or elsewhere in the Union, or in Northern Rhodesia, where exploration was also conducted. In the Kimberley mines of the group the decline in grade at depth has, it is understood, persisted. Block-caving methods of mining are being extended further in these mines and the group is erecting a new treatment and recovery plant, expected to be commissioned soon. Carrig Diamonds, exploiting a Kimberlite fissure in the Rustenburg area which has a high industrial diamond content, expects difficult underground conditions to continue being encountered for some months ahead. Meanwhile additions and modifications to the plant and the link-up with the Electricity Supply Commission network should improve returns.

Platinum

As far as can be estimated at present the recession in the platinum metal market had little effect on the overall 1957 returns; this should be reflected in the current year's figures. Last year Rustenburg Platinum Mines sunk its fourth shaft to a depth of about 1,500 ft., part of an expansion programme which was supplemented by further extensions to the treatment plant capacity to 2,600,000 from 2,200,000 tons of ore annually, but under present conditions the additional capacity will not be commissioned until metal-market trends improve. Output will be reduced to about 60% of the 1956–57 figure. Subject to final signature the Rustenburg company has increased its mining lease area by 5,166 claims. The Platinum Prospecting Co. (of the Central Mining-Rand Mines group, with which the United States Engelhard interests are now closely associated) placed its proved Brakspruit property in the Rustenburg area on a caretaking basis.

Coal

Domestic coal demands continue to exceed supplies and cannot be completely met

because of the persistent inadequacy of transport, rail and road, which again limited exports to a minimum. The transport position should improve this year even though only slightly and to a greater extent next year, 1959, but competitive conditions may then be keener in the export markets. Higher selling prices in the domestic market have partly offset narrowing profit margins, which makes financing, especially on the higher levels involved in mechanization (where applied in varying degrees), somewhat uncertain and poses difficulties in keeping costs down in circumstances which are increasingly demanding the offering of better all-round working conditions to employees, particularly artisan and native labour. The labour shortage is not uniform among the collieries, which in some cases are maintaining a surplus complement in the face of competitive conditions. To counter their labour shortage the affected collieries have applied or extended mechanization and may continue the process.

Programmes of expansion are in progress, including increased production of coking coals and coke and some new collieries are projected in the bituminous fields of the Transvaal, Free State, and Natal and the anthracite fields of the latter. Over the next three years coal consumption in South Africa is expected to increase at the annual rate of about 2,000,000 tons. New plant and equipment (including conveyor, washing, waste disposal, and surface storing and loading) are being installed to increase efficiences and improve the quality of output. Drilling in the coalfields of Transvaal and Natal was advanced further.

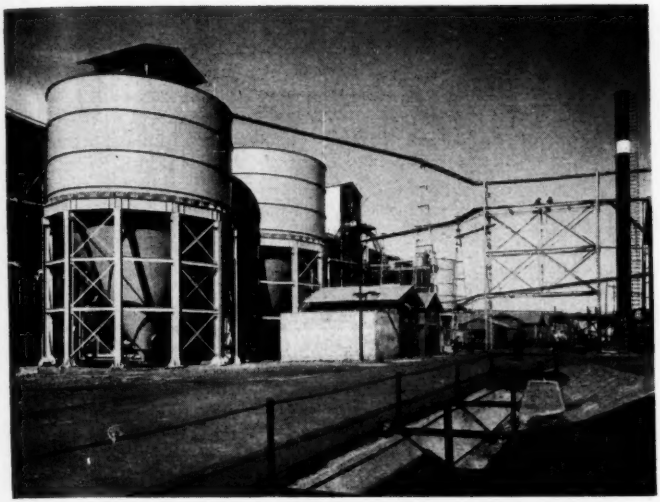
Other Minerals

Despite the labour shortages experienced by some asbestos producers, particularly in the Pietiersburg area of Northern Transvaal, expansion of output and sales advanced further in 1957 and seems likely to be sustained. Improved working conditions have been accompanied by intensified recruiting. Efforts to improve fibre quality were continued with apparently satisfactory results and electrification extended. Competition in the exports markets became keener. Working costs rose under the influence of higher labour and development costs. The Turner and Newall interests acquired four mines and centralized their production of amosite and Transvaal blue asbestos in the Pietersburg area. Providing costs can be held in check asbestos producers in South Africa regard the long-term outlook in both the domestic and export markets as encouraging.

Output by the north-western Cape manganese producers was maintained in 1957. Increased sales were met from accumulated stocks and resulted from a slightly better rail transport position. Consolidation, extension of holdings, development of new mines or quarries, and the proving of additional deposits or extensions were advanced further. In the Postmasburg district a number of small producers have been amalgamated. Domestic production of ferro-manganese was increased and new producing units are being erected or are projected by independent and other companies associated with the major manganese-ore producers.

A projected reduction of copper output was not reflected in last year's returns but should become evident this year. Extension of copper interests was again considerable. The Palabora Mining Co. was formed by Newmont Mining Corporation, Rio Tinto, and the Merensky Trust to explore the extensive low-grade copper deposit extending into the property of Phosphate Development Corporation in the north-eastern Transvaal. The Messina company extended its mineral holdings considerably in Southern Rhodesia including, *inter alia*, copper-lead-zinc, copper, scheelite, and limestone, as well as acquiring a substantial shareholding in the Rhodesian Iron and Steel Co. (Private), Ltd. The O'okiep Copper Co. announced a 10% reduction in copper output and effected sales of by-product bismuth ore and diverted staff to exploration and development. Preliminary exploration was initiated on sites of ancient copper workings east of Potchefstroom, Western Transvaal. The African Metals Corporation obtained encouraging results in its investigation of the Northern Transvaal Copper Co.'s property near Messina.

Chromite returns reflected general improvements, mainly due to better railings and new production. However, stocks were accumulated further by most producers, who may reduce output in 1958, owing to weakness in the export markets, although contractual sales will doubtless be a stabilizing factor in sales. The Winterveld Chrome Co. (Central Mining-Rand Mines group) last year initiated production. South African Minerals Corporation has suspended production of chromite. Increased domestic output of ferro-chrome can be expected.



Pulp Stock Tanks at a Uranium Plant.

The South African Iron and Steel Industrial Corporation is extending its expansion programme by an additional 900,000 tons to 2,350,000 tons of ingot a year at its two existing plants over the next few years. Consequently increased output of iron ore (mainly from the Sishen deposits in the north-western Cape), as well as coal and coke, limestone, dolomite, fluorspar, etc., can be expected. Other producers of iron ore will also probably increase production for export and domestic sales.

Main features in the tin sector were the further extension of electrification, plant modifications, and new installations (including spirals) to raise efficiencies and recovery and the commissioning of a new tin-scheelite section by the Zaaiplaats company.

Other points of interest were the reversion in its flotation plant by the Phosphate Development Corporation to phosphate-ore treatment, following concentrating tests on its low-grade copper ore; additional claims acquired by Consolidated Murchison (the antimony producer) which has already secured positive results from its extensive underground exploratory development programme; small-scale production started by Minerals Engineering Co. from its Marico-Zeerust vanadium deposits and its commissioning a pilot-plant refinery at Witbank, both in the Transvaal; erection started by Umgababa Minerals of its large-scale concentrating plant on the Natal South Coast for producing ilmenite, zircon, and rutile; pilot-plant production of molybdenite concentrate by Montrose Exploration Co. which also increased chromite production; Associated Ore and Metal's association with a major ferro-manganese project which may also produce pig-iron and its extension of asbestos interests and projected expansion of wonderstone for export, and the association of Middle Witwatersrand with base-mineral projects in Southern and Northern Rhodesia, including iron ore, coal, limestone, chromite, copper, nickel, and lithium occurrences.

To enhance its revenue-earning potential, South African Railways increased its tariffs on, *inter alia*, mine timber, cement, lime and limestone, coal and coke, precious and base-metal concentrates, chromite, manganese ore, iron ore, crude asbestos fibre, copper ingot, and other ores and minerals.

General

The extensive development programme of the South African Railways in 1957 was a factor in restricting traffic movement, including coal and ores for export and the domestic markets. Carrying capacities were expanded in the Free State, Transvaal (Witwatersrand-Vereeniging area); the Kimberley area, which affects traffic movements from the Postmasburg-Kuruman-Hay and Sishen fields, and on the Johannesburg-Kimberley-Cape Town main line. Work on the main line to Port Elizabeth (which may become the principal export port for manganese

ore) continued and further extensions (including electrification) on the Eastern Transvaal coalfield line and along the Johannesburg-Durban main line were put in hand. Certain other zones were to be, or were being, electrified further. Additional traction capacity was commissioned or ordered. Harbour facilities were being extended and plans approved for the construction of an additional harbour in Table Bay. Investigation of the alternative possibilities of linking up Swaziland either with the Eastern Transvaal South African Railways system or the Portuguese East African system was advanced further. The major items in the expansion programme of the South African Railways are expected to be completed in about four years' time.

Taxation of all mining companies—excluding gold and uranium producers, which remained on a formula impost—was increased to 6.5 s. in the pound by a savings levy of 0.5 s.

The Base Mineral Association was established to advance and protect the interests of producers in South and South-West Africa.

Measures were taken for the stricter control of industrial uses of water, the purification and re-use of effluent water, the prevention of pollution, and intensified research therein. Through an associated company New Consolidated Gold Fields indicated interest in developing and introducing new types of equipment for mechanising underground operations.

The Council for Scientific and Industrial Research extended investigation and research into airflow through mine shafts and participated in studies of the seepage of water, pumped to surface, back into underground workings, by means of tracers with positive results. "Spot-coolers"—small mobile refrigeration plants—are being increasingly applied in underground ventilation systems especially in development ends and deep mines. Experiments in the fragmentation of ore, through the use of modified explosive, were conducted to give finer run-of-mine sizings and thereby effect economies. The McNutt vibrated spiral concentrator was demonstrated. African Explosives commissioned a full-scale plant for producing igniter-cord and reported keener demand for Cordtex fuse.

The Electricity Supply Commission reported that mining requirements were being fully met and announced the erection of a new power station on the Komati River, Eastern Transvaal.

South-West Africa

The total sales value realized by minerals in South-West Africa in 1957 reflected a decline from the 1956 level, due to lower returns in respect of diamonds, beryl ore, lead-copper-zinc concentrates, lead-vanadium concentrates, salt, scheelite, and wolframite, returns which more than offset the notable increases in respect of copper ore, lead-sulphide concentrates, lime, the lithium ores, magnanese ore, tourmaline, sillimanite-kyanite, tantalite-columbite, tin and tin-wolfram concentrates, and zinc concentrates. In at least two cases—lead sulphide and zinc concentrates—special bulk sales were negotiated.

Consolidated Diamond Mines developed a new area and expanded output further, continued with its programme of modernizing and modifying plant and installing additional equipment, and had on its schedule the erection of a new recovery section. The company is appealing against a Court ruling against its petition for a declaration that the 1923 Statute establishing its mineral rights also conferred rights on the coastal strip between the high- and low-water marks. The ruling confirmed the Administration's grant of rights over the strip along the 180-mile stretch of coast from Orange River mouth to Luderitz to another company—Suidwes Prospekteerders. Industrial Diamonds of South Africa (1945), Ltd., opened up a new diamond terrace located in the company's Luderitz holdings, from which production was initiated. Extravagant claims of rich diamond disclosures in the Karasburg concession area of the South West African Diamond Corporation were officially denied, but reports have persisted that diamonds, as well as tantalite and monazite occurrences, were disclosed. However, it seems that prospecting operations, for the time being at any rate, have been suspended.

Control of the South West Africa Co. was acquired by a consortium consisting of New Consolidated Gold Fields, the Anglo American Corporation, and the British South Africa Co., against competitive bidding by the Tsumeh Corporation. The South West Africa Co., is an important producer of vanadium-lead-zinc concentrates from the Abenabberg deposits in the Grootfontein area, south-east of Tsumeb, is the holder of mineral rights over an extensive area and is a substantial shareholder in the Tsumeb Corporation.

The South African Minerals Corporation consolidated its position as a major man-

ganese ore producer, in which underground operations were initiated to supplement surface quarrying, and planned further improvements of its rail-head and port loading facilities. Production and sales of manganese ore were expanded markedly in a programme aiming at a monthly output rate of 13,000 tons. Exploration was intensified, with unconfirmed reports of disclosures of phosphates, vanadium, and radioactive minerals. The Corporation secured an extension of the period of its exclusive prospecting grants, including radioactive minerals. More recently there have been unconfirmed reports of developments in connexion with these grants, including association with new interests.

If anything last year saw an extension of interest in the territory's mining potential on the part of major companies. An extensive aerial and ground prospecting programme was advanced by the Anglo American group, while the Consolidated Gold Fields group initiated prospecting there and the Mineral Development Corporation (Pty.), Ltd., was formed by African Metals Corporation (of South Africa) and incorporated in the territory to take cession of and investigate certain mineral rights. Ten oil prospecting concessions were granted in the northern districts of the territory as the first phase in operations to search for any southern extensions of the Angola oilfield. There were unconfirmed reports of the discovery of a major copperbelt in the territory. Lorelei Copper Mines, exploiting on a small scale copper-molybdenite deposits in which reserves of 20,000,000 tons had been proved and/or indicated, planned an increased milling and treatment rate, including the provision of differential flotation of copper and molybdenum concentrates, but is believed to have deferred implementation of its plans owing to metal-market conditions. There have been unconfirmed reports of new control of the company. The Uis Tin Mining Co. continued under judicial management, improved its liquid position further and therefore justified the continuation of operations, subject to the governing factor of the tin price. Krantzberg Mines—in the Associated Ore and Metal group—consolidated its mineral holdings but suspended production pending a recovery in tungsten prices.

Progress with Underground Locomotives

The relative merits of the various types available are briefly discussed

A. E. Williams, Ph.D., F.C.S.

The present article sets out briefly to review the relative merits of diesel and electric battery locomotives as well as the use of shuttle cars in trackless mining. In the majority of mines some form of mechanical transport has to be used for conveying minerals to the pit bottom. The latter in a few mines represents the deepest point and in such cases powered transport is not always required, for by the use of a brake pulley and steel wire rope a train of loaded cars moving downhill will draw a train of empty cars up to the point required. The greater number of mines, however, are not so fortunately placed and power has to be expended in getting the minerals to the shaft bottom. In some smaller mines in Great Britain ponies are still in use for drawing the cars or tubs, while larger concerns may make use of rope haulage systems, conveyor-belts, or locomotives; all three are often in use in the same mine.

Where the working places are considerably below the level of the shaft bottom and the incline of the haulage way is appreciable a powered rope haulage system is commonly used to bring the material to the bottom level, but conveyor-belts may be employed where the incline is not too great. With rope haulage systems the cost of the initial installation tends to be greater than that for locomotives, while if there are many turns and bends in the haulage way the design of the installation becomes very complicated and even more costly. On the other hand, the use of locomotives is confined to practically level routes and it is the conveyor-belt which has tended to displace the rope haulage methods

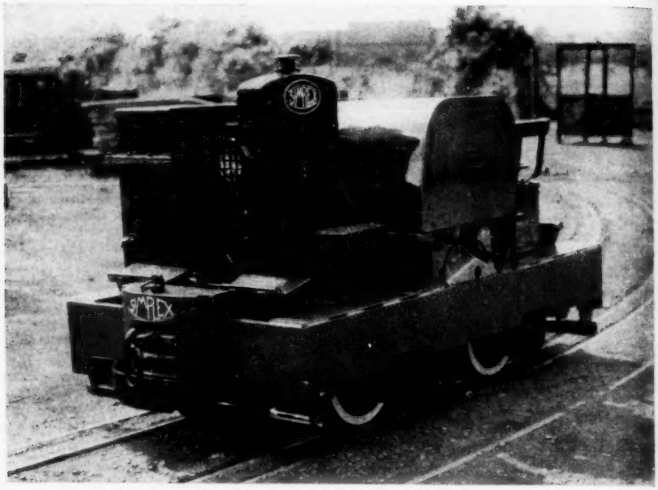


Fig. 1.—28-h.p. Diesel Locomotive.

(*Motor Rail Ltd.*)

on inclines which are not too steep. The use of conveyor-belts implies that the mineral is being carried in the loose state and not in cars or tubs, which means that either skips are used in the shaft, or the belts discharge into hoppers from which cars are loaded. It often arises that physical conditions underground favour the use of a particular method of transport, but the system adopted for shaft transport is frequently the deciding factor. So far as initial expenditure on a haulage system is concerned the use of locomotives, where applicable, tends to be the most economical. The locomotive itself is a self-contained power unit and the auxiliary equipment used underground to service the unit is not excessive. Providing that sufficient headroom is available, inclines are not too steep, and the track is sufficiently sturdy to carry the weight of the locomotive, the use of the latter is often advantageous.

Choice of Electric or Diesel Power

Mine locomotives are for the most part powered in two different ways, by electric battery or diesel engine, and each has its good and bad points. The diesel unit is normally applied to non-gaseous mines, while the electric unit when properly designed can be considered a safer proposition when there is any likelihood of gas being present. Possible disadvantages of the diesel engine underground are that it takes a portion of the limited air supply from the haulage way and it emits fumes which could contaminate the air current. However, in modern designs these fumes are taken care of and very little contamination occurs. In the United States diesel locomotives are being increasingly employed in metal mines. According to the Chief of the Health Division of the U.S. Bureau of Mines tests have shown that 122 analyses of air with diesel units under full load were mostly satisfactory, although in a few cases it was necessary to increase the quantity of air passing into the mine or to make mechanical adjustments on the units themselves. Since diesel units consume a certain amount of the air which has to be placed there by the ventilating fans it follows that the use of diesel locomotives has to be associated with good ventilation.

With the electric locomotive there is no consumption of air, nor is the latter likely to be contaminated. Batteries, however, have to be fairly frequently charged and changed; equipment is now in use to minimize loss of time in changing batteries. Generally speaking more power is available from the diesel than from an electric unit of the same size. The electric locomotive has for some years been of the flameproof type, while recent models of the diesel are also flameproof and carry the Buxton certificate. In designing locomotives for underground work size has always to be taken into account, and also weight; while the maximum power must be obtainable from the smallest possible mass. Size is important because many haulage ways far from the shaft bottom are no more than 5 ft. in height; weight must be taken into consideration because the loco-

motive has to go down the shaft and be supported by the winding rope. In this connexion some units can be taken into two or more pieces for transport in the shaft, but some are small enough to be taken down in one piece. Maximum power is necessary to deal with irregularities in the track level when the locomotive is under load. The builders of mine locomotives have long considered these requirements and it is now possible to have a 100-h.p. unit running on a 30 in. track and weighing only 15 tons, the height of the locomotive being no more than that of a mine car.

Diesel Locomotives

Diesel locomotives for underground use are made in powers from about 25 h.p. to 100 h.p., the smaller units being particularly suitable for operation in supplying the main haulage way, which latter is powered by the larger units. Some of the more recent 100-h.p. locomotives, however, have been specially designed to enable them to operate in quite small roadways when required. Power requirements for a given haulage road are considerably reduced by the use of aluminium-alloy tubs and cars, since the deadweight for a specific mineral load is less. Where a locomotive is already in use hauling steel tubs or cars the substitution of light alloy for steel enables the number of units in a train to be increased without increasing the load on the locomotive. The complete redesign in aluminium alloy of standard steel tubs can triple the load/tare ratio, for example, from 2 : 1 to 6 : 1, while the more common practice of replacing the steel body with one of light alloy and still retaining the existing steel underframe can increase the load/tare ratio to 3 : 1.

An example of a 2½-ton 28-h.p. diesel locomotive is seen in Fig. 1 and is fitted with an exhaust quencher to minimize the contamination of the mine atmosphere with exhaust gases. In contrast to this small unit Fig. 2 depicts a 9-ton 65-h.p. diesel locomotive operating in a Free State (South Africa) gold mine. This unit is running on a 30-in. gauge and the loaded mine cars are discharged into hoppers at the shaft bottom for skip winding. In general the smaller diesel locomotives, such as 2½ tons to 4½ tons, have two cylinders only, employing direct injection ; the bore being 115 mm. and the stroke 130 mm. Cylinder liners are usually chrome-hardened and are detachable for cleaning and inspection. Forced-feed lubrication is used and the engine speed is controlled by a mechanical governor from 350 r.p.m. to a maximum of 1,800 r.p.m. A gearbox provides two speeds in either direction, the change-speed gears being in constant mesh, and the whole gearbox is enclosed and dust-proof. When a heavy load is being hauled and the rails have become wet slip is avoided on the wheels by the use of a sander unit operated from a foot pedal from the driver's seat. Other controls the driver handles are throttle, clutch, brake, and warning signal. The cooling system embodies a detachable tube radiator so designed that each tube can be removed quickly for repair, etc., when needed. The radiator is cooled by a fan and the cylinder water jackets are connected to it by large-diameter copper pipes, so permitting

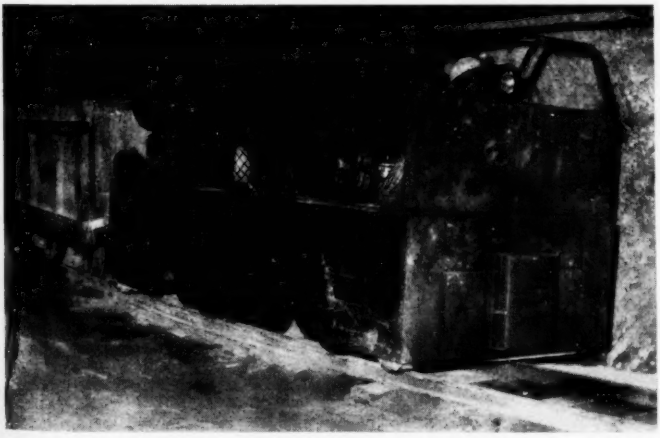


Fig. 2.— 9-ton 65-h.p. Locomotive in a Free State Mine.

(*Motor Rail, Ltd.*)

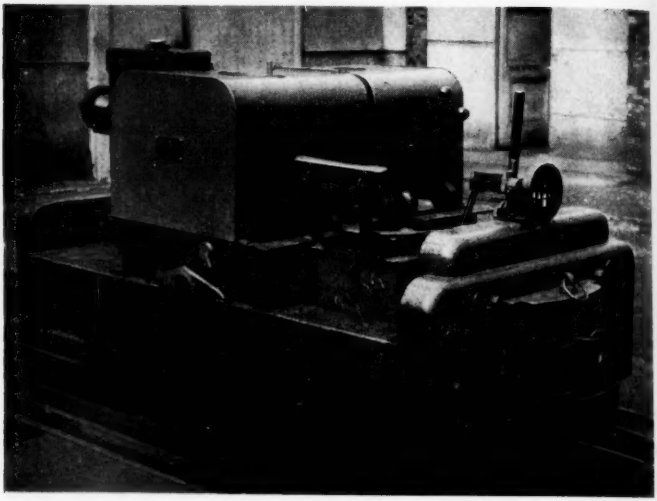


Fig. 3.— Short Locomotive Much Used in South Africa.

(*Motor Rail, Ltd.*)

efficient circulation by the thermo-syphon principle with thermostatic control. In place of this and for very hot mines a circulating-water pump is used.

The larger diesel-type locomotives make use of three cylinders having a bore of 120 mm. with a 180-mm. stroke and there are generally three speeds available on these. From the gearbox heavy roller chains take the drive to each axle. In other respects they resemble the smaller units. There is a tendency at present to make the locomotive framework by welded construction (Fig. 3) instead of the older riveted structures as formerly used. Lighting may be either through a 12-V battery, generator, and the necessary switches, with headlamps fore and aft, or by means of a batteryless set. The latter type has proved to be particularly favoured in out-of-the-way districts because battery maintenance is obviated. Average fuel consumption is about 0·40 pints per b.h.p. per hour, giving an average of 4 gallons to 5 gallons per shift of 8 hours. Consumption of lubricating oil is about $2\frac{1}{2}\%$ of the fuel oil consumption.

Even the larger locomotives can negotiate a curve of 18 ft. radius, but in normal operation when hauling heavy loads the rails are laid with radii of not less than 30 ft. With smaller locomotives and concomitant shorter wheel-bases much sharper curves can be successfully negotiated. Since the mine locomotives run on rails which are not always on the level and sometimes incline appreciably it is necessary to have good brakes, since the cars themselves often have no braking system and the locomotive is relied upon to control a load many times its own weight. In most cases the brakes operate on all the wheels of the locomotive ; the smaller units employ a screw brake-block on all wheels, but the larger locomotives use power-operated brakes.

Hydraulic Transmission

For a number of years the principle of transmitting hydraulically the diesel engine power to the wheels of a mine locomotive has been put to use. Such locomotives are manufactured in Britain by the North British Locomotive Co., Ltd., and incorporate a Voith-North British fully-automatic transmission. The use of hydraulic transmission makes for longer engine life because there are no mechanical connexions between engine and wheels ; thus any undue stresses on the latter are not transmitted to the engine. Control of the locomotive is simplified and is confined to braking, reversing, and throttling. Due to the absence of a clutch the locomotive may be accelerated more quickly ; this acceleration is smooth and stepless since no mechanical linkage is involved in the transmission.

These desirable features are obtained by the use of several different hydraulic fluid circuits and each of these has a specific range of operating speed. Depending on the power required from the locomotive at any

given period, the hydraulic fluid—oil—is transferred to the appropriate circuit without the necessity for gear changing or the movement of a clutch. This movement of oil from one circuit to another is operated through the medium of a mechanical governor which in turn operates in accordance with the speed of the wheels. The diesel engine operates a pump to maintain the necessary hydraulic power at the required pressure and also circulates the oil through a cooler to maintain optimum transmission conditions. These locomotives are no bigger than ordinary types and they are being applied to relatively narrow roadways as well as to main haulage roads. The power may be as much as 100 h.p., with a weight between 12½ tons and 15 tons, track gauge being according to requirements.

Power from the Batteries

Battery locomotives have been used successfully in many types of mine for a number of years and it is considered that for certain duties and underground conditions this type of locomotive is preferable to any other form of haulage. The large electrical engineering companies have developed battery locomotives intended for main road haulage and fast man-riding duties, which embody a number of features, the most important of which is the arrangement of the traction motors and their reduction gearing. By the use of a double reduction gear and the introduction of an idler into the gear train the motor need not be confined within the space between the road wheels but may take full advantage of the entire locomotive width. By this means relatively large motors may be employed on small rail gauges, while maintaining the diameter of the wheels at a minimum. Such features of design and the use of small-diameter road wheels permit of the installation of a large-capacity battery within the available headroom. Although axle-hung motors are used the unsprung weight on the track is a minimum and this results in reduced track maintenance. These advantages are obtained while at the same time retaining the simplicity of straight spur gearing.

Control of the traction motors is carried out by a set of electromagnetic contactors operated by a driver's controller arranged for series and parallel connexion of motors. The arrangement is such that in cases where the duty requires a locomotive of about 24 tons, two 12-ton locomotives may be coupled together as one unit and operated by one driver from any of the cabs. The locomotive, Fig. 4, may have a driving cab at one end only or one at each end. For either type the battery used is a single unit and is arranged for rolling off the locomotive when recharging is necessary. While the arrangement of the battery as a single unit facilitates changing batteries in a very short time, the battery is divided into a number of small sections so that it may be transported easily in a small cage. The interconnecting cables are connected in flameproof boxes, thereby avoiding the burning of lead to make joints underground. Westinghouse air brakes with an emergency feature are employed, with provision for operating the air brakes on man-riding cars or other rolling stock. A typical

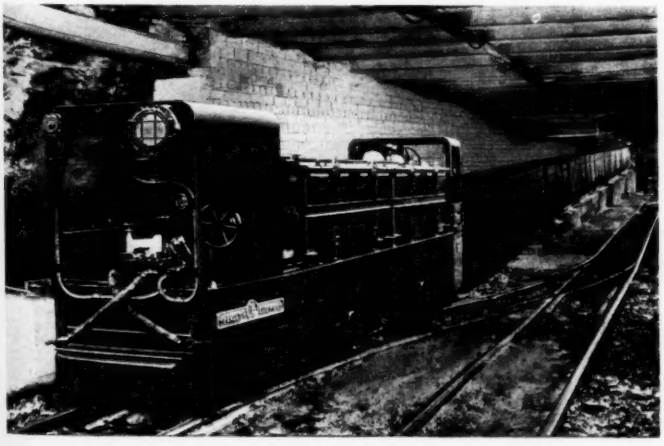


Fig. 4.—Flameproof Battery Locomotive.

(English Electric Co.)

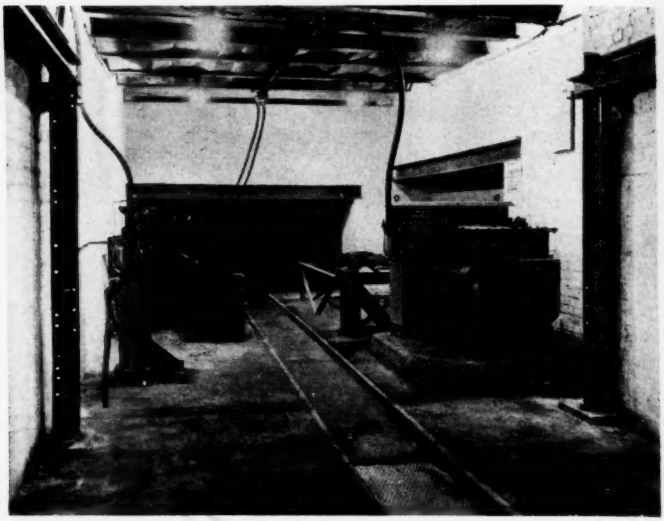


Fig. 5.— Underground Battery Charging Station.

(*English Electric Co.*)

locomotive of this type weighs between 12 tons and 13 tons, it has two motors, the total one-hour rating being 64 h.p. at 200 volts ; the speed is approximately 8 m.p.h.

Charging Batteries

Much time is saved in the transport of batteries if the latter can be charged underground and charging equipment for use underground has been developed for use with the battery locomotives. Two standard arrangements are available, corresponding to 94-cell and 100-cell batteries, and suitable for connecting to any a.c. supply between 2,750 V and 3,300 V, 3-phase, 50 cycles, while equipment is also available for almost any battery size and supply voltage. A typical standard equipment consists of a rectifier cabinet to convert a.c. to d.c. and a transformer mounted on a common underbase for easy transportation (Fig. 5). A separate a.c. circuit breaker is required but a d.c. circuit breaker is not necessary for the charger is connected directly to the battery by plugs which are inserted in the battery main power sockets. A feature of the rectifier equipment is that it employs glass tube excitrons, which are single anode mercury-arc rectifiers of small size and simple construction, being specially suitable for installation underground, where the size of any equipment is necessarily restricted.

The charging equipment is so designed that a charging current received by a battery is dependent on its terminal voltage at the time of plugging-in and correctly corresponds to its state of discharge. A locomotive which has had a very light shift and has not used much current from its battery can therefore be run into the charging station and made ready in a very short time with a fully-charged battery for the next shift. An inherent characteristic of a battery of this type is that once " gassing " has commenced a constant time is required for completing the charge irrespective of the initial state of discharge. A high rate of charge is thus applied initially, tapering to a lower value as the battery voltage rises. When the battery voltage reaches the value corresponding to the gassing conditions a voltage relay is energized and operates a change-over contactor. Additional reactance is inserted in the supply to the rectifier, reducing the charger output voltage, and the battery consequently receives a lower charge. The voltage relay also starts a synchronous timing device which terminates the charging operation after a preset constant time by tripping the a.c. circuit breaker. These automatic arrangements make it possible for a semi-skilled person to operate the charging equipment with perfect safety. In practice it is merely necessary for the locomotive driver to plug the charger into the discharged battery and the remainder of the charging operation is entirely automatic.

Low Haulage Ways

In many mines the amount of headroom

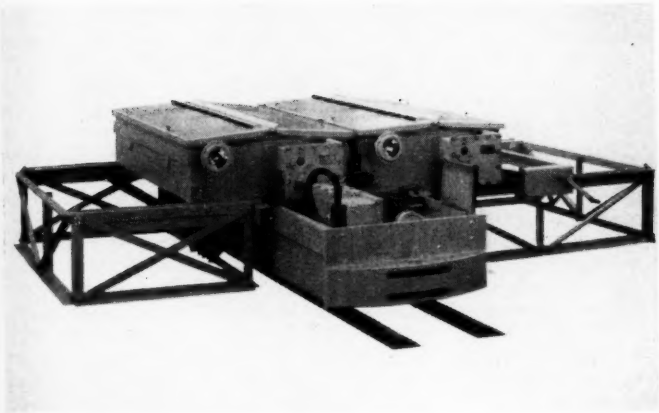


Fig. 6.— Charging Batteries on a Locomotive for Low Haulage Way.

(Wm. McNeill and Son (St. Helens), Ltd.)

tends to get less and less as one gets further away from the shaft bottom, for more care is given to the construction of main roadways since these will be in existence long after a particular by-way is worked out. It follows that if locomotive haulage is to be employed in low roadways the locomotive itself must be of appropriate height. There are in fact locomotives which can be used on a haulageway which has little more than 4 ft. of headroom. One such locomotive is depicted in Fig. 6 which shows the method of changing batteries. This locomotive has a height of 4 ft. 1 in. and is equipped with two motors, each of 17½ h.p., making a power unit of 35 h.p. These smaller locomotives are useful in operating by-ways in which the traffic in minerals is not so heavy as on the main haulageway. In normal practice they are used as feeders to the main haulageway and as they are flameproof they can be used far into the interior of the mine without danger of explosion. Safety in gaseous mines is ensured by the fact that the electrical equipment mounted on the battery box consists of a flameproof case which contains a hand-operated double-pole circuit breaker, with magnetic overload trips, which is mechanically interlocked with a 4-pin power socket in such a way that the switch cannot be closed with the plug out and the operating handle is locked in the off position if the plug is only partially inserted, unlocking when the plug is pushed fully home. This ensures

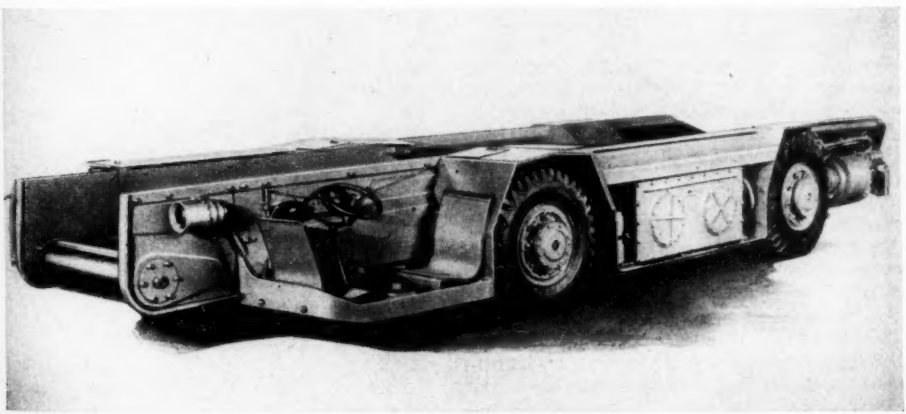


Fig. 6.—Joy 6SC Shuttle Car.

that the socket cannot be made live unless the plug is correctly in position.

Replacing a run-down battery with a fresh one is done by a mechanical device, seen in operation in Fig. 6, the entire operation taking less than 5 minutes. The locomotive, under its own power, is brought into position at the changing station and a number of U-shaped rods which serve to hold the battery box in position on the locomotive are lifted and dropped into receptacles fitted in the corners of the battery box, thus forming a rigid connexion between the battery on an adjacent rack and the one on the locomotive. The hooks on the carriage are then engaged with the nearest battery box and by turning a handcrank on the framework of the charging equipment the operator can move both batteries in the required direction. In other words, the new battery pushes the old one off the locomotive and takes its place. Each alternate change requires that the batteries be moved in the opposite direction, which is done by simply reversing the handcrank.

Trackless Mining

Trackless mining underground with rubber-tyred haulage units has found acceptance in various types of mines and the " locomotive " most commonly used in the absence of rails is the shuttle car, often employed in conjunction with a mechanical loader. The shuttle car in combination with loader offers speed and flexibility in the tonnage handling of various minerals. The prospective use of diesel-powered haulage lends itself to the application of trackless mining—for example, diesel-operated bulldozers for cleaning up, loaders, and trucks with duck-board trailers for transport, all mounted on rubber-tyred pneumatic mountings, giving maximum flexibility and speedy operation. In mines where trackless haulage has been adopted the shuttle car is practically an essential unit to operate with loading machines in order to take full advantage of the loader. A typical shuttle car is seen in Fig. 7. This car is provided with two separate steering systems, one hydraulic and one mechanical. In the event of failure of the hydraulic system the operator still has complete manual control of the machine. Due to its long wheel-base the shuttle car remains steady when passing over the rough ground of the mine and this feature enables the unit to operate with less roof clearance, since the ends of the car do not rise appreciably. Many types of mining require transport in narrow passages and this is allowed for in the design of the shuttle car, for its method of steering permits right-angle turns in very narrow places.

One type of shuttle car is provided with a two-speed conveyor, the high speed being used when unloading directly into mine cars or conveyor-belt hoppers, while the slow speed permits unloading directly on to belt-conveyors without overloading the belt. One of the latest transmission developments, the no-slip differential, has been incorporated into some types of car. Like conventional differentials this mechanism permits the outer wheels to rotate faster than the inner wheels when turning a corner. However, in the shuttle car the wheels are positively prevented from spinning and if one wheel runs into a hole and starts to spin the non-slip differential automatically transmits full driving power to the opposed wheel; thus the shuttle car cannot bog down in bad ground unless all four wheels stick at the same time. The use of shuttle cars is quite compatible with the employment of conveyor-belts and locomotives, for these cars are essentially " front-line " units operating right in the working places and bringing back materials to feed either belts or cars. In small mines or those being developed where the underground area is still small the shuttle car normally feeds the skip hoppers at the pit bottom.

Nickel Refining

It has recently been announced by the Mond Nickel Company that a paper presented at the annual meeting of the American Institute of Mining, Metallurgical, and Petroleum Engineers held in New York in February described a new process for the electro-refining of nickel developed by the International Nickel Co. of Canada. Described as a major achievement in chemical metallurgy, a main feature of the process is the direct electrolysis of nickel matte and artificial sulphide. This contrasts with the usual electro-refining methods, including those employed in the nickel industry, in which a metal anode is used. The new process eliminates high-temperature oxidation and reduction operations, with attendant losses of metals and sulphur and selenium. Instead, nickel sulphide of low copper content from the Bessemer converter or other source can be cast directly into sulphide anodes and

electrolyzed for the production of high-quality nickel. Another unique feature of the process, it is stated, is that it permits the commercial recovery of elemental sulphur and selenium as valuable by-products in addition to cobalt and precious metals conventionally recovered. It is considered that the development constitutes another step in Inco's programme to obtain the maximum recovery of useful elements from the ore it mines.

The new process, for which, it is stated, Canadian and United States patents are pending, is in commercial operation in a section of the company's Port Colborne, Ontario, nickel refinery. Sulphur-selenium separation is accomplished in a 100-ft.-high fractionating column of special design. The interesting possibilities of the new method were first demonstrated in laboratory tests in 1951, when a small piece of cast nickel sulphide was electrolyzed. It corroded smoothly, the nickel and other base metals passing into solution, leaving a precious-metal bearing anode sludge containing 97% elemental sulphur. A number of obstacles to the recovery of sulphur of high purity from the sludge were resolved by laboratory and pilot-plant investigations, these studies, conducted jointly with the Blaw-Knox Company, resulting in the construction of a novel 100-tons-per-day sulphur fractional distillation unit. The sulphur from this unit contains less than five parts per million of selenium and has an unusually low ash and bitumens content. The selenium residue is shipped to Inco's copper refinery at Copper Cliff, Ontario, where it is processed for recovery of pure selenium.

Ore-Dressing Notes

(12) *Gold.*

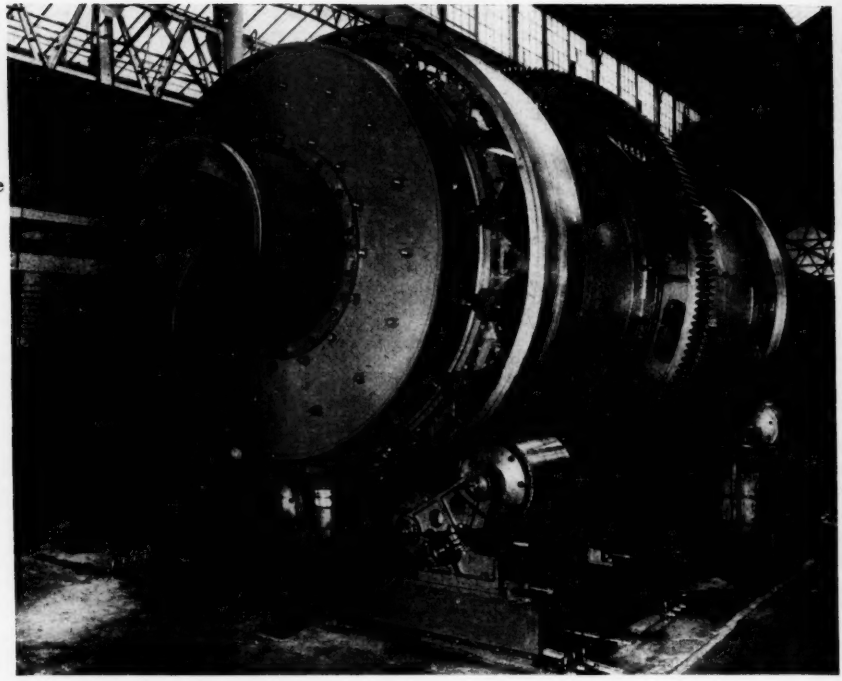
Loss on Roasting

It is commonly found when auriferous pyrite has been "sweet roasted" that after cyanide treatment of the resulting calcine a final residue containing 6 dwt./ton or more must be discarded. Studies made by O. J. Parker on Kalgoorlie calcines [1] have shown that the loss in the case examined is due to occlusion of gold in dense pyrrhotite, which is formed by fusion inside the pyrite grains during their decomposition. The degree of fusion of this kind is directly associated with the balance between the rate of raising the temperature and that of expulsion of sulphur from the pyrite. When these are relatively controlled the fusion is limited and an expanded structure more amenable to cyanidation is formed.

It is generally agreed that a calcine having high porosity is required for good recovery and that a low roasting temperature is essential while the sulphur is being removed. Among the reasons for this have been the suggestion that at too high temperatures an insoluble coating forms over the gold and that the gold is lost in residual sulphide. "Low" roasting temperature is taken as below 600° C. during the expulsion of the labile sulphur, which occurs in the early sections of a roasting furnace such as the Edwards. Roasting of an autogenously-fuelled feed begins with oxidation of the pyrite. The sulphur which burns above the bed toward the feed end of the furnace has been expelled and does not radiate sufficient heat to do the oxidation. Its heat is largely lost with the excess gas travelling out. The sulphide actually oxidized, as distinct from that from which sulphur is sublimed, provides the roasting temperature, the rate of oxidation being the factor which governs any fusion occurring in the grains of sulphide. The author takes the temperature of the uppermost material as of the order of 1,000° C., which confirms earlier work, although temperature in the body of the roast is below 600° C. Thus, conversion temperatures range from above 1,100° C. in the surface area of full exposure to the furnace gas (flash roasting conditions) down to 575° C., the lowest dissociation temperature of labile sulphur. The great bulk of the reaction proceeds somewhere between these extremes.

The investigation was concerned to attempt to produce a porous sulphide structure by expulsion of labile sulphur without fusion. Pyrrhotite is a solid solution of sulphur in ferrous sulphide (troilite, FeS) and the change to the pyrite (FeS_2) phase proceeds with added sulphur and diminution of the troilite. The research problem appeared to centre on the re-arrangement of the troilite lattice without disturbance of the pyrite. One-gram. samples of *minus* 100 *plus* 170 mesh auriferous pyrite (a flotation concentrate) were used for tests. In the 600° C. to 650° C. range the grains expanded to 2·4 times their original volume.

[1] *Proc. Aust. Inst. Min. Metall.*, June, 1957, part I.



Blade Mill for Washing Manganese Ore.

(*G.E.C.*)

Incipient fusion appeared at 700° C. and by 1,100° C. all grains were interfused and shapeless and volume had shrunk to 0·77. Microscopic examination showed structural expansion to accompany expulsion of sulphur simultaneously with recrystallization to troilite or pyrrhotite and fusion of pyrite, the evidence indicating that pyrite melted at 575° C. in the reaction. With limitation of the fusion an expanded structure, with the contained gold more accessible for cyanidation, was produced. This expanded form is obtained by control of the rates of heating and sulphur expulsion and is best achieved, in the author's thesis, by a two-stage fluidized roast which is not feasible in an Edwards roaster.

Investigation next moved to the examination of fluidization effects, in the 600° C. to 900° C. range, using nitrogen gas. From various tests it was concluded that the best leaching structure was formed in a fluidized decomposition bed held at 675° C. by regulation of air deficiency (rate of oxidation). Cyanidation tests followed and maximum extraction of gold (95·2%) was found to occur from pyrrhotite formed at 650° C. Residual gold value at 4·9 dwt./ton for the expanded pyrrhotite is high by Canadian production standards, but for the complex Kalgoorlie ores the work described suggests that a valuable line of investigation has been opened up.

(13) *Flotation.*

Agglomeration of Manganese

In *Mining Engineering* for December, 1957, E. H. Yates gives details of a novel commercial application of flotation to the treatment of wad (a complex of manganese oxides including psilomelane, hollandite, coronadite, and pyrolusite). A feature of major importance in the treatment of wad can be the necessity for recovery of good-grade manganese from the slime produced during grinding. This may contain a considerable amount of the value in the tonnage handled and is therefore an important objective. The purpose at the Three Kids Mine in Nevada was to develop a suitable commercial application and this is claimed as now secure. The

chief gangue minerals are quartz, opal, kaolinite, montmorillonite, calcite, gypsum, celestite, and barite. Most of the manganese values are porous or sponge-like and clay is of near colloid size. Hence there is considerable surface area per unit weight and this can be as high as 58 sq. metres per gram. As one result an unusually high reagent consumption is quoted in the paper.

The ore is crushed to *minus* 1 in. and rod-milled in closed circuit. Sulphur dioxide solution is added as the pulp leaves the grinding and is immediately followed by the addition of soap, oil, and wetting agent mixed to form an unstable emulsion which is kept dispersed by being fed into the pulp as it passes through centrifugal pumps to the conditioning section. All reagents are added before conditioning and intense mechanical stirring follows, with heavy power consumption. Up to 38 kWhr. of energy per dry short ton may be necessary on a pulp carrying between 18% and 23% of solids during conditioning. Conditioning is followed by roughing with one scavenging and four cleaning stages. A finally granulated concentrate of agglomerated manganese mineral particles is taken from the final cleaning operation, sintered, and nodulized. A. W. Fahrenwald in 1955 was the first to correlate the energy input in conditioning with the manganese recovery, but what was happening was not at that time fully understood. The present hypothesis is that the sulphur dioxide which is first added allows the ore minerals to release manganese ions to the pulp. These ions are believed to sorb to the manganese minerals, forming active surfaces for reaction with the soap in the emulsion. Hydrogen-ion concentration is not yet well understood in this connexion. It would appear that activation and flotation can take place over wide ranges of pH. The emulsion is composed of tall-oil skimmings, petroleum oil, a petroleum sulphonate wetting agent, and water. These are emulsified in due proportion and then measured to the pulp. The soap is taken up by the activated manganese minerals as insoluble manganese soap molecules oriented with their hydrocarbon chains outward. Removal of the excess soluble soap is believed to produce a break in the emulsion freeing the oil so that it films the manganese minerals by preferentially wetting those glomerules which are covered with fatty acid. Mechanical energy is then used in a series of 20 conditioning tanks. Thence agglomerate particles are built by a fusion of the oil films. The kneading action in this intensive conditioning appears to consolidate the weakly bonded flocs into dense agglomerates which produce heavy granular froth loads during the flotation process which takes place in conventional cells. The sulphonated petroleum product in the emulsion controls the size and the density of the agglomerated particles, presumably by modifying the surface energies at the water and oil interfaces. These glomerules are of the order of 100 mesh to 200 mesh size. Instead of sulphur dioxide in the first stage of pulp treatment other heavy-metal ions could be used to influence the surfaces and copper, iron, and lead are mentioned in this connexion as well as manganese sulphate. The active components of the tall-oil soap skimmings are fatty acid and rosin acid sodium soaps. The principal reagents in tall oil are oleic and linoleic acid which are themselves the most effective collectors. The petroleum mixture is of gas and diesel oil. Other hydrocarbon oils can be used instead. A sodium alkyl aryl sulphonate is used as the petroleum sulphonated product. The emulsion used in the mill circuit contains about 20% of total active ingredients and 80% water. A blend consists of between 25 lb. and 40 lb. of soap (dry weight), 120 lb. to 180 lb. of petroleum oil, and 5 lb. to 10 lb. of petroleum sulphonate. In addition about 8½ lb. of sulphur dioxide are required for adequate activation of each ton of manganese. Because of the porosity and the near colloid material which is being agglomerated very large quantities of reagent are used per ton and the description given in the paper would indicate that this must be an extremely expensive matter.

Several varieties of ore are treated—freshly mined, weathered, consolidated, crystalline and micro-crystalline, and clay-like ores. Conditioning may take anything from a few kWhr. per ton of a crystalline type up to 100 kWhr. per ton for freshly-mined clay-like ore. Blending is used to produce fairly steady working conditions. This brings the power consumption to 38 kWhr. per dry short ton. Fagergren cells were used in laboratory testing and are also incorporated in the commercial flow-sheet. Experience has shown that the amount of mechanical energy used in the pulp is the important conditioning factor rather than the rate at which it is applied. The impeller must be so shaped as to transmit plenty of mechanical work into the pulp. A temperature rise of some 14° F. occurs at this stage and has a beneficial effect.

Engineering Log

Because of the expense involved chemical and physical processes for turning sea water into fresh have not been used much except for military or naval projects, the large-scale installations, such as those at Kuwait and at Aruba, Netherlands West Indies, being justified only by the value of the oil production which they assist. Last year, however, a new departure was made by the Pacific Gas and Electric Company of San Francisco, which established a small plant on the coast at Morro Bay to convert sea water to high purity for use in boilers—the first non-experimental use of demineralization plant in the United States. At a cost of $1·96 per 1,000 gal. water is cheaper than it would be from any other available source on the site and considerably lower than the $5·60 cost at Kuwait or the $3·50 at Aruba for the same quantity of water, although it is thought that expansion of the installations at both these places will halve costs. The United States Department of Commerce has given $2 per 1,000 gal. as the price which some industries can pay for water and for municipal and irrigation purposes 35 cents and 13 cents respectively are the prices. At the same time an Atomic Energy Commission official has told the California Legislature that the price of water produced by atom-powered demineralization plants would be 25 to 39 cents per 1,000 gal. and cities there and elsewhere are already in many instances paying 30 cents. Such figures are based on a theoretical output of at least 500,000,000 gal. per day, as against Morro Bay's 144,000 per day, which accounts for the comparatively low cost. Since 1952 the United States Department of the Interior has spent over $2,000,000 on research on demineralization and the programme is to continue. It is now supporting some 21 operations and requires a prospective maximum cost of $1·50 per 1,000 gal. before sponsoring any further projects. The present water consumption of the United States is 200,000,000,000 gal. a day and this figure is increasing by 10,000,000,000 gal. annually while expenses and the difficulty of obtaining additional supplies are increasing all the time. Hence a lively interest in demineralization is likely to be shown, particularly in areas within reach of the coast. Besides continued experiments with distillation the process used at Morro Bay, Kuwait, and Aruba, research projects include solar distillation, membrane filtration, freezing, solvent extraction, and ion exchange. Fresh water can be produced at a cost of from 30 cents to $1·25 per 1,000 gal. Demineralization is likely to be particularly valuable in regions where deep pumping for irrigation purposes yields salt-contaminated water, as well as for those—such as the Orange Free State goldfield—where brackish waters are abundant and fresh water scarce.

* * *

The pressure of industrial growth makes strong demands on available supplies of water. It is therefore interesting that power is now available to aid in the re-adjustment of the water to land ratio on the surface of the globe just at a time when new methods of desalting promise to become of economic importance. The problem of water in Australia, which is the dryest of the continents, is somewhat different. Cities have sprung up on the coast and farm lands have developed inward. The continental interior is relatively undeveloped, however, because of its aridity and uninviting difficulties. The only way to overcome the sterility produced by this lack of water is by the use and the development of power systems which will bring water artificially to where it is wanted. One important new development has been the use of hexadecanol, a chemical developed by C.S.I.R.O. to reduce evaporation at the surface of pools of water. This it does to the extent of anywhere up to 60%. When hexadecanol makes contact with water it gives off a film which spreads to a unimolecular thickness over the water. Small ripples on the surface or drinking animals break the film, but this is renewed from a store which floats in a raft and automatically replaces the break with a new supply of molecules. The system is not yet of use in water where there can be heavy waves and is only recommended to seal areas which are sheltered and calm. The cost of saving water in one community was of the order of one penny per 1,000 gal. for a 37% reduction in loss. Another type of loss is that due to seepage, which is considerably greater. To counteract this an Australian engineer has suggested that earth dams should be given a polythene plastic coating in order to put a watertight floor beneath the conserved area. This is still in the " ideas " stage.

[1] *The Economist*, July 13th, 1957.

It seems probable that beryllium may soon be used along with the many other metals now being employed to produce American weapons systems. Because of the need for a lightweight material which will retain its strength at temperatures of up to 1,500° F. Brush Beryllium Co., Cleveland, Ohio, have entered a contract with Air Materiel Command to develop techniques for producing sheet beryllium suitable for this application. The contract awarded by the Manufacturing Methods Branch of the Command calls for the rolling of sheet beryllium from pressed-powder slabs. On a strength-to-weight ratio basis beryllium has three times the strength of steel and its weight is about $\frac{2}{3}$ that of aluminium. It maintains its properties at 1,000° to 1,200° F. Beryllium-base alloys are being developed for use at up to 1,500° F.[1]

* * *

The possibility of obtaining power from thermonuclear reactions now appears to be accepted following the joint announcement by the British and U.S. governments on thermo-nuclear power research. The experiments reported have received various appraisals, but Mr. Lewis L. Strauss, chairman of the Atomic Energy Commission of the U.S.A., concedes that " to-day there are almost no sceptics " as to the feasibility of thermonuclear power in the long run. The chief question is whether a true thermonuclear reaction has yet been achieved. Experiments with very hot ionized gases (plasmas) have produced neutrons from the fusion of deuterium nuclei. It is not, however, certain whether the fusing atoms obtained the speeds necessary to the reaction from local accelerations in the electrical fields of the plasma or from the general heating throughout the gas which is the condition for thermonuclear reaction. Sir John Cockroft, of Britain's Atomic Energy Authority, has stated that it is " 90% certain " that the English device known as ZETA (zero-energy thermonuclear assembly) has produced thermonuclear neutrons. Publication of the American and British results shows considerable relaxation of the secrecy which has enveloped thermonuclear research. Some areas of information are still classified. The British periodical *New Scientist* attributed the security restrictions to America's fears that neutrons from the thermonuclear reactors could be used by small nations to make fissionable plutonium from U-238 so that they would no longer be dependent on U.S. or Soviet sources for materials to make the atomic bomb. While many U.S. scientists claimed that secrecy had not hampered the research there were dissenting voices on this point.[1]

* * *

The Bahamas California Oil Company and Bahamas Gulf Oil Company announced in Nassau, Bahamas, last month that the two companies are to drill an exploratory test well on Cay Sal Bank, a small island approximately 180 miles south-west of Nassau. The well is to be drilled under oil prospecting licences held by the two firms who are wholly-owned subsidiaries of Standard Oil Company of California and the Gulf Oil Corporation respectively. The site was selected after two years of extensive seismic work over Cay Sal Bank at a cost of over $400,000 and the well will cost nearly $3,000,000 ; it will be one of the most expensive ever budgeted in the history of the petroleum industry. It is to be drilled to a maximum depth of 15,000 ft. from a self-contained platform located in 30 ft. of water. This platform will be above anticipated wave crests and will contain all the necessary drilling equipment including derricks, engines, and mud pumps, together with accommodation for the drilling crew.

* * *

A new polyester-based poly-urethane rubber, called Genthane S, is being manufactured in pilot-plant quantity by an American company. It can be put into full production as soon as there is sufficient demand. The new product is said to be completely resistant to oil and ozone and capable of storage for an indefinite period without deterioration. Best ageing properties are shown at extreme temperatures. Genthane remains rubbery at −40° F., is not brittle at 100° F., and does not crystallize. It therefore promises to be especially useful for arctic and upper atmosphere purposes. Other claims made for the new material are that it outwears any other known rubber, has superior resilience and resistance to abrasion, is stable and non-scorching, has excellent adhesion to synthetic fibres and metals, and that unlike other polyurethanes it can be processed on standard rubber machinery. It is expected that immediate applications will be in valves, gaskets, oil

[1] *Machinery*, Mar., 1958.

[1] *Scientific American*, Mar., 1958.

hose, O-rings, oil seals, pumps, insulating covers, vibration absorbers, and lightweight shoe soling. Tests of its suitability for tyres are under way. The development of Genthane follows the recent production of another polyether-based urethane, Polyfoam. The foam is also said to be noted for durability and production of other foams has been discontinued. Polyfoam is less than half the weight of natural latex foam and is said to have a high degree of compatibility with other materials.[1]

News Letters

VANCOUVER

March 11.

Legislation.—In an effort to appease to some extent the various mining interests, including public and private organizations, mining companies, exploration companies, and prospectors, the British Columbia Government has issued a further amendment modifying the terms of leases as proposed under Bill 91, adopted by the Legislature early in 1957. Whereas the staker of a mineral claim was, under the Bill, required to apply within five years for a production or retention lease, which could be issued at the will of the Minister of Mines for a period of 21 years, under the amended policy there will be only one type of lease to extend for 21 years. Renewal for a further period of 21 years is guaranteed if the property has come into production. Failing such evidence of development renewal *may* be granted if certain work has been done and fees paid during the first 21 years. One lease may include 16 claims, equivalent to approximately 51 acres. When claims are staked the assessment requirements are, as formerly, work to a value of $100 or payment of that sum per year. There is no limit to the number of years such claims can be held. Once a 21-year lease has been issued work requirements call for $4 per acre and a fee of 50 cents per acre for each of the first 10 years and then at the rate of $6 per acre and $1 per acre for the following 11 years.

The Government has apparently made an effort to meet the demand for greater security of tenure, but states most emphatically that it is standing on the principle of leasing, as opposed to Crown-granting. In justifying the sharply-increased cost of assessment required the Department of Mines points out that " we feel that no Crown land should be put into private hands without a reasonable fee being paid to the Crown."

The requirement that a lease has to be in production at some time in the 21-year lease period does not mean that such production has to be maintained continuously, or to the date of expiry of the lease, in order to obtain renewal. The production is clearly defined as being nominal and can occur at any time in the period. This is interpreted to mean that if a lease holder found that economic conditions were such that he had to close his operation he could do so without fear of losing the right to renewal of his lease. However, in cases where there has been no recorded production, the application for renewal appears through inclusion of the word " may," to be subject to ministerial discretion, one of the points so bitterly assailed throughout the past year.

Vancouver.—The Britannia Mining and Smelting Company closed its mining and milling operation at Britannia Beach on March 1. The mine had been in steady production, with the exception of short periods during which it was strike-bound, for more than 50 years and had provided for a community of 2,000 persons with a payroll of approximately 800. Frantic efforts were made late in 1957 to keep the operation alive despite sagging prices for copper and increasing operating costs. The Federal Government agreed to advance $16,000 monthly and the Provincial Government $4,000 in order to assist the Howe Sound Company, which owns all the stock of Britannia, in meeting the operating loss. Despite this assistance, however, instructions were received from head office that operation would have to be suspended because of the progressively deteriorating price of the principal metal produced.

The first indication that closure was imminent became known last autumn when the company asked its employees to take a 15% cut in wages. This was refused by the International Union of Mine, Mill, and Smelter Workers and the company announced its intention of suspending operation. Then came the Federal and Provincial offers of assistance and some concession by the union in the matter of overtime economies. As a result the company reconsidered its

[1] *Chem. Enging*, Nov., 1957.

policy and agreed to continue on a reduced scale; approximately half the 800 employees were laid off in the past three months.

To the end of 1956 the Britannia mine produced 427,342 oz. of gold, valued at $13,584,889; 4,618,761 oz. of silver, valued at $2,769,821; 901,840,366 lb. of copper, valued at $145,445,016; 15,727,855 lb. of lead valued at $1,499,503, and 174,221,615 lb. of zinc, valued at $23,030,872. The company also periodically marketed large quantities of iron pyrites. The gross value of production has been close to $200,000,000 or approximately 5% of the lifetime mineral production of the Province of British Columbia. The report of the Minister of Mines for the Province shows total dividend payments of $18,803,772 by the company.

Skeena.—Premier Border Gold Mining, the former Portland Canal base-metal producer, has advised shareholders that it has added to its oil holdings by the acquisition of a 4·6% interest in the capital stock of Petroleos Atlas de Guatemala, S.A., a corporation organized under the laws of the Republic of Guatemala to explore for oil and gas in a section comprising 97,945 hectares in the north-western part of the republic. Several major United States and Canadian oil companies have acquired concessions in the vicinity, which is within 80 miles of a prolific producing field in Mexico. The geology is described as being favourable to oil deposition. Premier Border is also active in exploration for and production of petroleum in Western Canada and is at the same time maintaining its mine, adjoining the Silbak Premier, in good order in anticipation of renewed operation when base-metal prices become more attractive.

Kamloops.—Spectacular results of diamond-drilling exploration have been reported by Craigmont Mines, Ltd., near Nicola. Hole No. 15, put vertically from surface in the heart of a large indicated anomaly, has encountered high-grade copper ore with strong iron mineralization. From collar to 170 ft. the only assays have been obtained from sludges with indication of 0·5% copper content; the following 120 ft. average 1·75% copper and 30% iron; from 320 ft. to 500 ft. the grade increased to 6·25% copper with 40% iron and a 60-ft. section exceeding 10% copper. Hole No. 16, also vertical, has been directed from the western boundary of the indicated anomaly. This hole has recently entered material of approximately 1% copper grade with increasing concentration as depth is gained. The Craigmont development is being conducted under the management of Canadian Exploration, Ltd., the wholly-owned subsidiary of Placer Development, Ltd. Excellent results were obtained in several earlier holes and the pattern of a large high-grade copper ore-body with interesting iron values is beginning to emerge. The property is easily accessible from main highways and is within ten miles of rail connexion and both the Trans Mountain oil pipeline and the Westcoast Transmission gas pipeline.

The Craigmont property is situated at the southern extremity of the Highland Valley copperbelt, in the development of which most of the big-name copper-mining companies are engaged. Noranda Exploration has obtained a lease-option agreement from Midnight Consolidated Mines covering a group of 54 mineral claims adjoining Craigmont on the north. Tarbutt Mines, Ltd., a company headed by Mr. J. H. Hirshhorn and Mr. Franc R. Joubin, has acquired a group of 64 claims to the east. Further to the north is the well-known property of Bethlehem Copper Corporation, which has been under intensive development with encouraging results by the American Smelting and Refining Co.; Asarco also has a number of other properties in the Highland Valley under option. The Phelps Dodge Corporation is exploring under agreement the 1,000-claim property of Jericho Mines, Ltd., and Northwestern Explorations, Ltd., the exploration subsidiary of the Kennecott Copper Corporation, is carrying on extensive drilling on two separate properties in the "belt," a term widely applied by geologists to the area. First major underground work to be done in the recent revival (the copper mineralization has been known for 75 years) was performed by Trojan Consolidated Mines towards the northern end of the belt. This met with gratifying success at a depth of 150 ft. and indicated that actual car samples were of considerably higher grade than the assays obtained from diamond drilling. Because of the nature of the ground it is necessary in most cases to extract "NX" or 2⅛-in. core, thus making exploration a very costly item.

Lardeau.—Sunshine Lardeau Mines has reported an estimated profit, before provision for depletion or depreciation, of $39,064 in the three months to January 31. The shipment of 812 tons of lead concentrate and 1,080 tons of zinc concentrate together with 174 tons of crude oxidized ore brought net smelter returns of $186,833. Development work

during the quarter was limited to 1,826 ft. of diamond drilling, all from surface. Mining is proceeding on the Eclipse vein and preparation has been made for the "underhand" mining of the No. 4 vein from the 10 level. Because of the exceptionally favourable winter weather it has not been necessary to stockpile concentrates as in former years.

Yukon.—All mining and milling has been suspended by Galkeno Mines until more favourable base-metal prices obtain. The company has made application for nine permits covering oil and gas exploration rights in a 420,550-acre block in the Northwest Territories. Should the tender be successful it is proposed to proceed with a reconnaissance geological survey. The ground is situated in an area under active development by a number of prominent petroleum companies. It is proposed to issue 5-year 6% debentures to provide funds to the amount of $400,000 to cover the cost of the proposed oil exploration.

Beaver Lodge Uranium Mines, Ltd., a British Columbia company with holdings in the Highland Valley, has acquired a 70% interest in a gold-silver property 35 miles from Denver, Colorado. The Beaver Lodge investment amounts to $240,000, with the Contract Engineering Co., of Denver, holding the remaining 30%. Beaver Lodge shareholders have been informed that the company's participation should be recoverable from even a small-scale mining operation. Plans call for production to ensue during the coming summer. Initial operation is planned at 75 tons daily with provision for increase to 100 tons. Pre-production expense will be returned out of first production.

TORONTO

March 20.

Gold Production.—For January the 30 producing gold mines of Ontario reported milling 779,128 tons of ore having a content of 219,502 oz. of gold and 31,562 oz. of silver and a total value of $7,462,598. In the previous year the mines reported milling 759,681 tons containing 210,404 oz. of gold and 33,082 oz. of silver, the total value of which amounted to $7,114,391. In January there was an average of 10,997 wage earners and the average grade of ore amounted to $9.58.

North-Western Ontario.—It is reported that the directors of McKenzie Red Lake Gold Mines, in the Red Lake area, have decided to place the mine on a salvage basis. The decision follows extensive underground exploration which, it is stated, failed to disclose new ore of economic value. A new programme for the company is under consideration. The company's 125-ton mill started operations on March 1, 1935. In the interval total production has been over $18,000,000 and dividends have amounted to $3,066,450.

Sudbury.— The International Nickel Co., of Canada reports net earnings of $86,141,000 for 1957, dividends equal to $3·75 a share requiring $54,690,000. In the year 290,050,000 lb. of nickel and 280,810,000 lb. of copper were produced. The total ore mined from the company's Sudbury District properties was the largest yet achieved, exceeding 16,000,000 tons for the first time, as compared with 15,500,000 tons in 1956. The proved ore reserves, exclusive of Manitoba, at December 31, 1957, stood at a record of 264,495,000 short tons. This compared with 264,224,000 short tons at the end of 1956. The nickel-copper content of these reserves also showed an increase, it is stated.

At a recent ceremony the president of Falconbridge Nickel Mines, Mr. H. I. Fraser, formally opened the new smelter. The transferring of operations to the new plant is to be made in stages without interrupting production. Built at a cost of $5,000,000 the plant includes a blast-furnace and two Pierce-Smith converters, together with auxiliary blowers and power-house equipment. Measuring 300 ft. by 180 ft. the smelter with present equipment handles about half the company's total production.

Manitoba.—In the report of International Nickel for 1957 shareholders were informed that the 1,057-ft. development shaft of the Thompson mine was completed shortly after the end of the year while sinking of the production shaft, which will reach a depth of 2,100 ft., was proceeding on schedule; it should be completed in the autumn. Development work was also carried on at the Moak Lake mine.

Quebec.—The Quebec mines reported an output of 80,761 oz. in November, 1957, the total for the first 11 months of the year being 920,946 oz., which compares with 956,922 oz. in the corresponding period of 1956. The 11-month silver production in 1957 is given as 3,328,465 oz., to which the

November contribution was 294,716 oz. The November asbestos output totalled 89,665 tons bringing the 11-month figure up to 947,046 tons.

Six aeromagnetic maps covering ground in the Chibougamau area of Northwestern Quebec have been issued by the Department of Mines and Technical Surveys. The maps, on a scale of one inch to one mile, are: Map 519 G, Opemisca Lake; Map 538 G, Lac Boisvert; Map 539 G, Lac a l'Eau-Jaune; Map 542 G, Chibougamau; Map 544 G, Riviere de l'Epervier, and Map 540 G, Dickson Lake.

In a recent report shareholders of Copper Rand Chibougamau Mines have been informed that the company is proceeding with development and construction of its mill and when the plant is ready for operation early next year arrangements will be made for the tonnage of ore developed at Chibougamau Jaculet to be mined and milled by Copper Rand. It is hoped that income from this source will be sufficient to permit the last-named company to proceed with further development work in the expectation of outlining additional ore on the lower levels.

Three new furnaces are to be added to the equipment of the Quebec Iron and Titanium Corporation at Sorel, the cost of expansion being given as $16,000,000. By the time the programme is completed early next year it is estimated that the overall output of titanium slags from Allard Lake ore will have been raised to 375,000 tons.

MELBOURNE

March 20.

Western Mining Corporation.—With the recession in the market price of base metals stability at the moment seems to rest with tin and gold, even if the latter suffers under an inadequate, although fixed, price. Western Mining Corporation has been, and is, a strong force in the gold-mining industry in Australia and in general the work of its subsidiaries continues to be substantial and to give much promise for the future. Central Norseman Gold Corporation, in Western Australia, continues to increase an already strong position, developments continuing to yield good results, while Great Western Consolidated has reported that at the Fraser's mine, at Southern Cross, two drill holes at No. 3 level have intersected reef assaying 14·6 dwt. over 107 in. and 12·2 dwt. over 122 in., both intersections 40 ft. behind the foot-wall of the old level. At No. 6 level in this mine the crosscut to Sholl's lode cut two lodes; the first, from 92 ft. to 102 ft., assayed 7·5 dwt. over 120 in. and the second, from 112 ft. to 118 ft., assayed 9·2 dwt. over 72 in.; average over the total width of 312 in., from 92 ft. to 118 ft., was 5·5 dwt. A previous diamond-drill intersection 15 ft. above these lodes gave 8·4 dwt. over 176 in. Fraser's mine has been regarded favourably over a period of nearly 40 years since active mining ceased but has remained idle except for some diamond-drilling in the middle 1930s. Great Western Consolidated's work is indicating ore-bodies of some importance. Position at the Nevoria mine seems uncertain as yet but has apparently improved since underground work was commenced; latest work has shown values of 11·4 dwt. and 8·2 dwt. at No. 3 level over short distances.

The Corporation has always been very active in mineral exploration, mainly for gold, in Western Australia. It has just been reported that the Corporation has secured from the Western Australian Government a reservation of 2,000 sq. miles in the West Kimberley country. The area covers an extensive copper mineralization which outcrops at a number of places within a distance of about 30 miles. The showings of copper are situated about 60 miles from Derby, to the south of Collier Bay, on the north-west coast of the State.

Royalties.—Royalties are to be imposed on all minerals produced in Western Australia with the exception of gold, coal, and oil. All minerals which are used in their native state and have a value of less than £10 per ton will pay a royalty of 6d. per ton; in this class will be barite, bauxite, bentonite, clay, dolomite feldspar, gypsum, glass sand, magnesite, ochres, talc, and vermiculite. Other minerals usually sold as concentrates will pay a royalty of 1s. per ton of concentrates with a value below £10 per ton, covering graphite, ilmenite, pyrite, phosphates, and zircon. Where the value of the concentrates is between £10 and £50 the royalty will be 1s. 6d. per ton; this group will include copper (for fertilizers), chrome iron ore, manganese, rutile, and glauconite. Other minerals and concentrates sold by the ton—such as, asbestos, beryl, copper, lead, monazite, tin, and zinc—will be charged a royalty of 2s. per ton. On minerals of high values—such as,

tantalite, columbite, mica, and scheelite—royalty will be ½% of the value. Because of the considerable fall in the market price of lead and copper royalty will not be levied on these minerals at present.

Oil Search.—West Australian Petroleum has moved its operations from Exmouth Gulf to the Canning Basin in the north part of the State. It is stated that the company is very hopeful that the search planned will give encouraging results. The Canning Basin is a new field of exploration and is quite unconnected with the Exmouth Gulf area. A substantial amount of geological and geophysical work has already been carried out in the new area and indications are believed to be quite encouraging. The first well, at Samphire Marsh, has reached a depth of 2,359 ft. in sandstone. Further geophysical work will use seismic refraction equipment, which was not available when the original geophysical work was done two years ago.

North Broken Hill.—North Broken Hill, Ltd., has for many years been working leases originally worked by the Block 14 Company and by the British Broken Hill Company, which latter became part of the North property some time before the acquisition of Block 14. The remaining ore in these leases is practically exhausted and it is announced that Blackwood shaft, on the British, which has been in active use for over 70 years, is now out of production as ore has been exhausted in this part of the mine. Men employed in the Blackwood shaft area—this shaft commenced work in 1888—are to be transferred to the North section. The second important shaft in the British section—Thompson's—is also to close soon. There is still ore in this part of the mine but its extraction will probably be done through the Junction section.

With the working out of the British ore-bodies the line of lode will be abandoned between the Junction mine and the old Broken Hill Proprietary Company's leases, which are now being worked in the upper levels by Broken Hill South, Ltd. In the North mine itself the steepening of the pitch below the 3,000-ft. horizon and a general enlargement of the ore-body have had a very important influence on the ore-reserve position and the future at depth. Deep levels of the ore-bodies in the North section will be served by the new main shaft and the ventilation shaft, which are now nearing the horizon for which they have been planned.

Maranboy Tinfield.—The Maranboy tinfield, in the Northern Territory, has been worked in an irregular manner for a number of years by small groups and individual miners, assisted by treatment of ore in a Government battery. There has been considerable production of tin oxide from numerous workings which reached a shallow depth only and the field was eventually abandoned. Within the past two years a company has been interested, but its interest was finally passed to a group comprising King Island Scheelite, United Uranium, and Loloma (Fiji) Gold Mines, which has been exploring at greater depth with reported encouraging results.

With the increasing local demand for tin, following the establishment of tinplate works in New South Wales by the Broken Hill Proprietary Co., it has become imperative that Australia produce more tin if importation is to be avoided, but under previously existing conditions domestic production was below consumption. The Commonwealth Government is impressed with the future position and is to assist the search for new tin deposits. As a first step it is intended to diamond-drill the Maranboy tinfield, which is considered to have possibilities of being developed to a substantial output. An agreement has been reached with the operating group and six bores will be drilled by Government, the cost of this work to be defrayed if the field reaches the productive stage.

Uranium. — Uranium mining in South Australia is a State activity. The Government operates the Radium Hill uranium mine, which sends concentrates to the State's chemical treatment plant at Port Pirie. New ore-bodies have recently been discovered in the country adjacent to Radium Hill and a contract has been let for the exploration of the area by diamond drilling. This work, it is estimated, will cost £A17,000. In addition, the Mines Department has authorized 4,000 ft. of surface drilling and 2,000 ft. of underground drilling at the Radium Hill mine itself, the cost of which is estimated at £A10,000.

The Radium Hill locality has been proved to be a uranium field of importance. After extensive prospecting there Mount Painter, in the Flinders Ranges, was originally attractive but proved to be disappointing. Recent prospecting there, however, is reported to have given results which are considered to be worth further investigation. It is generally held that the Government policy of confining uranium to Government activity has greatly retarded the development of this mineral in the State.

Aluminium.—Trends in the development of the aluminium industry, based upon the great bauxite deposits at Weipa on the Cape York Peninsula, North Queensland, point to the treatment works being established in Central Queensland. It has been announced by the Minister for Mines that Commonwealth Aluminium Corporation Pty., Ltd., has taken an option over the Blair Athol coalfield, south-west of Mackay. The resources of this field will approximate 200,000,000 tons of high-grade coal, all workable by open cut. Estimated consumption by the proposed aluminium works is between 2,000,000 and 3,000,000 tons per year. Plans considered in the agreement include the construction of a power house on the Blair Athol coalfield and the construction of an aluminium smelter at a port in Central Queensland using power from this station.

The agreement with the Queensland Government provides for the construction of an aluminium smelter within 25 years, but it is now forecast that a smelter may be erected within this time. It has not yet been decided whether the alumina factory will be built at Weipa, on the bauxite deposit, or in Central Queensland, near the proposed site for the smelter. Cost of the alumina factory has been estimated at £A50,000,000, which would include, at Weipa, the cost of building a town, port, and all transport facilities. If alumina is to be made in Central Queensland bauxite would be shipped by barge to the selected port, for which the town of Mackay seems to be the favoured location. Meantime exploratory and proving work is in progress on the bauxite field, but operations are not advanced far enough to permit estimation of the tonnage of ore to be expected within the Corporation's concession.

Peko Mines.—At Peko Mines, N.L., at Tennant Creek, Northern Territory, development work has been mainly of a preparatory nature rather than the development of new ore. Sinking of the main shaft has been continued to a total depth of 1,024 ft., which appears to be the final depth for the present. Despite the fall in the price of copper production is being maintained. In the past four weeks production was 9,256 tons of ore milled for the recovery of 2,475 tons of concentrates having a grade of 25·26% copper and 9·20 dwt. gold; metal contents are given as 625 tons copper and 1,138 oz. gold. This mine is the only copper mine in the Northern Territory and is of considerable importance for its size. It was originally worked as a gold mine, copper not appearing in the upper levels. It is characteristic of Tennant Creek gold mines that, except in possibly one instance, there has been no trace of copper in the auriferous workings. The gold shoots usually cut out between depths of 100 ft. and 300 ft. and much money has been spent in the unsuccessful effort to locate repetitions at greater depth. The Peko copper lode was found below a depth of 400 ft. and has been opened up as a strong ore-body up to 30 ft. wide to the 1,000-ft. horizon and is quite devoid of the sudden cutting out feature characteristic of the auriferous lodes. The success of Peko led to considerable activity in diamond drilling below the gold occurrences in abandoned mines, but in no case has a commercial copper occurrence been located.

Victorian Gold.—Under present conditions there is little hope of reviving the Victorian gold-mining industry, as there is no inducement to the re-opening of idle mines which have legitimate exploratory prospects. The only increase in production that might be looked for is from success by Morning Star (G.M.A.) Mines' deep exploration work, which to date has been disappointing.

Nevertheless there has been some slight increase in the State's production. For the month of January production was 2,900 fine oz., which is an increase of 657 fine oz. compared with the same month of 1957. The only exploratory work in progress outside the few active mines has been diamond drilling by Gold Mines of Australia in the old Stawell goldfield. Drilling has been in progress intermittently and there has been some encouragement in the results obtained.

North Kalgurli (1912).—North Kalgurli has now built up its ore reserves to a point where it is one of the big mines of the Golden Mile. It is well equipped and in comparison with its neighbours the depth of its workings is shallow. Ore of good grade continues to be developed. In the last quarter of 1957 development totalled 6,058 ft., of which 1,033 ft. was in payable ore of 4 dwt. and over. High-grade ore was met in diamond drilling, which totalled 4,557 ft. for the period. In the North Kalgurli section at No. 9 level an intersection gave 26 dwt. over 12 in. In the Kalgurli section at No. 3 level a 9-in. intersection assayed 56 dwt. In the Croesus section at No. 5 level 15 in. assayed 17 dwt. and at No. 7 level 10-dwt. ore was met over 12 in.

SINGAPORE

March 10.

Tin.—The Federation of Malaya Government has announced its full agreement with the creation of a fund to be put at the disposal of the manager of the International Tin Buffer Stock to enable him to buy more tin to stabilize prices. An official statement said that the Government had received a full report from the Federation delegation to the ninth meeting of the International Tin Council in London, when the question of the fund was raised. The statement said: "The Government has noted particularly that the participating producing countries have unanimously agreed to recommend to their governments to consider the creation of a special fund to be put at the disposal of the buffer stock manager." The Government wished it to be made known that "with the full concurrence of both the Asian and European sections of the tin industry, it has agreed to the creation of this fund." In addition the Federation Government pledged its determination to "support all measures" taken by the International Tin Council to maintain the effective operation of the International Tin Agreement.

About 70 mines, including four dredges, had stopped working in the northern Malaya region by March 1, the majority in Perak State and the rest were in Province Wellesley, Kedah, and Perlis. About 90% of the mines had shut down because they had completed their permissible quota of tin production for the current period and 2,300 persons had been thrown out of work. The mines are expected to resume production on April 1 with the start of a new quota period. An additional eight mines have closed in Selangor. However, a large number of applications to re-open Chinese mines, many of them out of production for some time and without a quota for the current period, is causing concern. So far in Perak alone about 80 applications were said to have been submitted for re-opening such mines.

Equipment.—Following an investigation of the market in Malaya and Singapore by a mining engineer, Mr. George F. Graham, Australia expects to send more equipment to Malaya. Mr. Graham, employed by the Department of Trade in Adelaide, made a thorough study of prospects in Malaya for mining equipment and other engineering products and reported back to the Australian Government and to executives of leading mining companies and civil construction organizations. Commenting on Mr. Graham's visit an official of the Australian Ministry of Trade said there were good prospects of expanding sales of Australian engineering products in Malaya. In 1956-57 Australian exports to Malaya of engineering and mining equipment were said to be valued at more then (Malayan) $2,800,000.

Chinese Mines.—Tribute is paid in the annual report of the Perak Chinese Mining Association to the rôle played by the Kinta Valley Home Guards in protecting Chinese mines against the Communist terrorists in the Malayan jungles. It was disclosed that last year (Malayan) $840,000 was contributed to the fund for the maintenance of the force and it was urged that all Chinese miners, despite difficulties due to restriction of tin output, should continue to contribute. The association appealed to all Chinese miners to join the association, which now had 180 members out of some 400 Chinese miners in the state.

Iron and Steel.—The Federation of Malaya has under consideration the possibilities of an iron and steel industry, Mr. J. H. Harris, Chief Research Officer of the Federation's Department of Mines, told a conference of the Economic Commission for Asia and the Far East, held in Kuala Lumpur. Private proposals have been put forward, but he said "it may be necessary to revise earlier opinions on the non-feasibility of a Malayan iron and steel industry. An incentive to develop a local iron industry would be the prospect of improving the utilization of the local coal with the possibility of recovery of valuable by-products and the manufacture of fertilizers." Malaya, he added, might wish to take advantage of the proposed pilot plants in India and the Philippines for making iron without coking coal. The report of an ECAFE sub-committee on iron and steel pointed out that Malaya, with its iron ore, and Borneo, with its coal, could start a mutually beneficial trade in these materials. Both countries could have a small-scale iron and steel industry. Mr. Harris suggested Malaya as a suitable place for the setting up of the proposed ECAFE centralized research laboratory to service the iron and steel industry in the region.

Russian Tin.—It has been suggested in Ipoh that Russia should join the International Tin Council. Now that the Federation of Malaya is an independent country and a member of the United Nations, said

a spokesman for Ipoh miners, the Federation Government is in a position to try to get Russia into the pact. Since last year Russia has been exporting large quantities of tin, said to come from somewhere in the Caucasus and the Ural Mountains and also from China. Secrecy shrouds the potentialities of Russia's tin production, but it is believed that the motive for these sales may merely be the exchange of a surplus commodity for much needed foreign exchange.

JOHANNESBURG

March 28.

General.—The South African Association of Chambers of Commerce has estimated that the amount available on current account for imports in 1958 is likely to approximate closely to the corresponding 1957 figure without taking into account net capital movements. The indications are therefore that the country will be able to afford to maintain the import control pattern now operating and the Association is confident that total permits for consumer goods will not be less than the corresponding 1957 issues. An announcement is expected in the near future, possibly after the elections. The Association stresses the importance of removing import control and all other physical controls at the earliest possible moment.

The president of the World Bank, Mr. E. Black, as well as the South African representative with the Bank, have been on a visit to the Union, where discussions have been held with Government heads and State officials, preliminary, it is thought, to the initiation of formal negotiations in Washington for further loans to the South African Railways and the Electricity Supply Commission. Mr. Black also had talks with representatives of organized commerce and industry.

The chairman of the Klerksdorp Mine Managers' Association has called for a clear and concise summary of the uranium position in discussions between the Government and the Combined Agency, representatives of which will shortly visit the country.

The Government Mining Engineer expressed the view at the recent opening of a new hydro-electric station that asbestos producers of importance in the country might now perhaps take a greater interest in the domestic production of finished asbestos products, even for export, as well as developing the export markets for crude fibre.

Dr. H. J. van Eck, chairman of the Industrial Development Corporation, has stated that improved rail transport facilities for moving bulk traffic—such as, ores and coal—to the ports are urgently needed. The existing programme of railway expansion was such that another £400,000,000 might have to be spent in the next 10 years. He mooted the construction of a pipeline between the Rand and Durban to carry, *inter alia*, manganese ore and coal. Under the existing arrangements, he said, it would be several years before coal exports could be resumed (presumably on a large scale).

Transvaal.—Last year Randfontein Estates Gold Mining stepped up its sorting rate to 26·6% of the ore to mill which, with improved extraction and a slightly higher grade, raised the uranium yield and increased the effective capacity of the plant. A further increase in the sorting rate is expected this year and in due course it is expected the plant capacity will be more fully utilized. Underground operations are being confined to what is regarded as the higher uranium grade northern section. Payable gold ore is being rapidly depleted and milling will be further reduced this year.

The tonnage of payable ore in the uranium-bearing Bird Reefs of East Champ d'Or Gold Mining is expected to be exhausted before the end of the uranium contract in 1964. Payable ore likely to be developed in the new-lease section of 64 claims, recently granted, will not have any significant effect on the life of the mine.

The Rand London Corporation, Ltd.—a new name for the South West Graphite Mining and Refining Co.—which some time ago suspended operations in South-West Africa and has passed to new control, has secured participations in mineral options over about 14,898 acres in the Kinross area, held by the Anglo American group, over about 73,666 acres north-west of the Hartebeestfontein-Buffelsfontein mines held by Middle Witwatersrand (Western Areas), Ltd., in the Klerksdorp area and a substantial shareholding in the West Vlakfontein company. Drilling is in progress in the Klerksdorp option area where, in other zones, prospecting interest on the part of other mining companies has been unofficially reported as having been broadened.

The Komati (River) Power Station of the Electricity Supply Commission in the Carolina

area of the Eastern Transvaal has contracted for the supply of 290,000 tons of coal a month from Koornfontein Collieries, Ltd. The Koornfontein company is participating in the formation of the Blinkpan company and is to offer to its shareholders one Blinkpan share for every Koornfontein share.

Tweefontein United Collieries, in its drilling programme in the Witbank–Middleburg area, has indicated the existence of an adequate quantity of fair- to good-quality coal for a large colliery and in addition a substantial tonnage of lower-grade coal suitable for steam-raising in an electric-power generating plant. However, in the opinion of the company, narrowing profit margins do not justify the large investment required for the establishment of a new colliery.

Messina Transvaal Development.—The Messina Transvaal Development Company has completed a survey of the 50 sq. miles of its exclusive prospecting concession surrounding the Alaska copper mine, recently acquired, and has now had the concession extended over 90 sq. miles. A more detailed survey and geochemical investigation is now in progress. Further drilling in the Sanyati mines' property has increased the estimated ore reserves to 15,119,000 tons averaging 1·4% copper, 1·35% lead, and 2·85% zinc. A three-compartment shaft is to be sunk to facilitate the start of underground exploratory development. Metallurgical tests of concentrates are to be conducted. Drilling is continuing in a deposit of iron pyrites in the Mazoe area; the results already obtained have disclosed variable quality and thickness. Using induced polarization apparatus, prospecting has been resumed in the nickel prospect of the Lomagundi district. Rights over the company's Wankie Coal Concession have been extended for a period of five years in respect of the area already prospected.

Despite the further fall in the copper price in recent weeks Messina has continued to operate at a moderate profit. The company is effecting further economies to offset any further recession in the metal price or any prolongation of present prices. The ore tonnage produced in the 1956–57 year was increased to 76,300 tons a month from the previous average of 70,000, at a slightly lower cost and grade of ore, the latter raising the cost of refined copper to £130 a ton. Electronic control equipment has been installed in the mill with marked benefits in operations.

Orange Free State.—Freddies Consolidated, which is confining its operations to the North Section, expanded its mining operations last year, but, owing to the increase in the sorting rate to 26·7% of the mine ore against 14·5% previously, milling was reduced by 110,700 tons to 665,000 tons. However, both the gold and uranium yield was thereby beneficiated to 5·779 dwt. and 0·317 lb. per ton from 4·215 dwt. and 0·245 lb. respectively. In the current year both the development and stoping rate are to be increased and the tonnage milled is expected to rise again notwithstanding a further increase in the sorting rate. It is probable that the Khaki Shale band immediately overlying the Basal Reef and severe faulting will be encountered throughout the lease area with resultant high mining costs.

Natal.—Feralloys, Ltd., the initial issued capital of which, £1,000,000, will be held to the extent of 60% by Anglo-Transvaal Consolidated and Associated Manganese and the balance by undisclosed parties, will eventually expend about £12,000,000 on the project at Cato Ridge. Initially two furnaces are to be operated (increased over 15 years to eight) in the production of ferro-manganese and possibly pig-iron. Export earnings are estimated at about £2,000,000 a year, as compared with the total 1957 sales of manganese ore of about £5,300,000. Restrictions on the export of high-grade manganese ore from the country have been maintained by the Government in order to conserve the remaining resources, which have been increased substantially but are not limitless. Nevertheless export markets, particularly in the United States, have been hoping for Government relaxation of the existing restrictions on exports to a greater extent than was done in 1956. Manganese ore for the Feralloy plant will be supplied by the Associated Manganese company.

Cape Province.—The O'okiep Copper Co. has ordered its immediate future capital expenditure programme on a priority basis, instead of implementing this concurrently as previously. This has rendered possible streamlining or rationalizing staff without serious lay-offs, especially among the European section. The mill expansion had been completed to a tonnage capacity of 150,000 tons a month, but owing to the economic background the rate will be restricted to an average of about 125,000 tons a month.

South-West Africa. — The Diamond Dredging and Mining Co. (S.W.A.), Ltd., recently formed, has acquired the following

assets : A grant to prospect and mine for all minerals over a period of 10 years in a strip about 180 miles long from south of Walvis Bay to north of Luderitz and of a width three miles seawards from the high-water mark. The strip is on the seaward side of Diamond Area No. 2, in which pegging, prospecting, and mining is the exclusive right of Industrial Diamonds of South Africa (1945), Ltd., and the associated Diamond Mining and Utility Co. (S.W.A.), Ltd., subject to prior rights defined below, and along the coastal belt of which diamonds have been recovered in payable quantities mainly in bays and valleys facing south—*viz.*, Saddle Hill, Spencer Bay, Oyster Cliffs, Meob Bay, and Conception Bay. The Diamond Dredging company points to the interesting fact that all diamondiferous marine terraces, concealed under a thick cover from 30 ft. to 50 ft. of seaborne and wind-blown sand, so far located at Saddle Hill, Spencer Bay, and Meob Bay, occur south of rocky promontories of the present or former shore line and that practically all surface concentrations of diamonds are found on south-facing slopes. These facts, the company comments, suggest that the diamonds were derived from the seaward side.

Trade Notes

Brief descriptions of developments of interest to the mining engineer

Mechanical Splice

On the occasion of a visit paid to the Charlton works of **British Ropes, Ltd.,** of Doncaster, representatives of the Press were shown a new development in mechanical splicing for wire rope slings, including the method of manufacture and procedure for testing. The " Superloop " splice, which is illustrated, is applicable to most standard six-stranded ropes and is especially recommended for the company's own Blue Strand preformed rope. As it employs a slimmer tapered sleeve with a tapered tail the Superloop can be used in cases where a bulky splice would be impracticable, in addition to which the Flemish eye incorporated gives a true centre pull. A specially-developed fitting—the " Superloop Stirrup," intended to protect the eye from wear, is also available as shown in the illustration.

Drill Rod Coupling

Particulars have been made available by the **Craelius Co., Ltd.,** of 11, Clarges Street, London, W. 1, of the Streamflow coupling. The makers point out that the pressure build-up necessary to overcome the flow restriction and turbulence caused at the coupling ends in a drill string results in heavy pump loads, difficulty in the removal of cuttings, and insufficient cooling of the cutting medium. To overcome this a taper of pre-determined angle at each end of the coupling has been introduced,

the arrangement being such as not to impair the strength of the coupling; turbulence and loss of head have been reduced to an

absolute minimum by this method. Tests by various users and manufacturers have shown that the power required to pump through the rod is reduced considerably; power savings of up to 50% have been claimed. The following are among the outstanding features: Power required to pump water or mud through the string is reduced. Drilling costs are lower, as smaller-diameter holes can be drilled to greater depth. Improved diamond bit life by greater volume and higher pressure of circulating fluid.

Utility Geiger Counter

Particulars have been made available of a new low-cost general purpose detector of gamma, hard beta, and X radiation which uses a circuit evolved in the British Atomic Weapons Research Establishment. The instrument, which is illustrated, is a self-contained, lightweight, portable employing the latest type of highly sensitive low-voltage halogen-quenched tube, the counter providing three ranges of visual response by flashing neon, together with a loudspeaker count of each single ionising event at low radiation levels, thus giving an immediate appreciation of any significant flux change. As a guide to sensitivity typical background counts over chalk areas are 40–50 counts per minute, while over West of England granite, away from metalliferous areas, counts range from 110–180 per minute according to locality. The high-tension power is derived from a pack of internationally available 30-volt batteries. These

are assembled in a plastic case which is moulded from high-impact polystyrene for durability and insulation resistance. The current consumption under normal conditions is so low that with proper use of the batteries will exceed their declared shelf life. Thumb-operated control permits single-handed operation on the medium and low ranges, but an an extra-long shoulder strap is provided for convenience when field surveying or prospecting. Further information may be obtained from **Radiation Monitors, Ltd.,** of 52, Tottenham Court Road, London, W. 1.

Asbestos Factory in Lancashire

Last month the **Turner Brothers Asbestos Co., Ltd.,** a member of the Turner and Newall Organization, provided an opportunity of seeing the new South block recently opened at their factory at Hindley Green, near Wigan. The opening of the new block marks the completion of a £4,000,000 development project launched in 1947, the whole factory now occupying a site of some 140 acres. The North block was completed in August, 1949, and is devoted to the manufacture of power transmission and conveyor belting, while the new one will be engaged in the manufacture of various products, mainly brake-lining materials, a large proportion of which are supplied to **Ferodo, Ltd.,** an associated company. Glass textiles and resinated asbestos moulding materials are also to be produced.

The new block has provided increased

productive capacity for asbestos textiles, as well as a fuller use of the company's Duraglas glass fibres. While the bulk of the asbestos textile production of the South block will be devoted to brake-lining materials, Duraglas fabrics are used for filtration and heat, sound, and electrical insulation, although the most important single use for such materials is as plastics reinforcement. In addition the block is to undertake the manufacture of certain allied materials for other companies in the Turner and Newall Organization in order to obtain the benefits of centralized production.

The products from the original factory block include rubber and P.V.C. conveyor belting, rubber power transmission belting, and cord "V" belts. While the rubber conveyor belting is used in mass production systems, in quarries, and in other types of plant, the company's fire-resistant antistatic P.V.C. conveyor belting is supplied in large quantities to the National Coal Board for use underground.

Personal

C. P. DENNISON has left for Northern Rhodesia.

F. DIXEY, Director of Overseas Geological Surveys, has been elected F.R.S.

A. E. GRIMSDALE has been appointed director and commercial manager of the Metropolitan-Vickers Electrical Co., Ltd.

H. A. LAVERS has left for Tanganyika.

A. B. MACLAREN has been made a director of Mufulira Copper Mines, Ltd.

C. MAXWELL NORMAN has returned from the United States.

JAMES A. PIKE, B.C. manager of Newmont Mining Corporation of Canada, Ltd., has been elected president of the British Columbia and Yukon Chamber of Mines for 1958.

L. T. POSTLE, president of the Granby Consolidated Mining, Smelting, and Power Co., Ltd., has been re-elected president of the Mining Association of British Columbia. Mr. G. H. MITCHELL has been reappointed secretary-treasurer after an absence of three years during which time he was engaged as executive secretary of the Sixth Commonwealth Mining and Metallurgical Congress.

T. A. ROGERS, a Deputy Chief Inspector of Mines and Quarries, has been appointed H.M. Chief Inspector of Mines and Quarries with effect from June 1, 1958, in succession to *Sir* HAROLD ROBERTS who retires on May 31.

JOHN W. SEMMENS is now in Mexico.

MURRAY W. STOWELL has been appointed general manager of Broken Hill South, Ltd.

HANS A. VOGELSTEIN, president of American Metal Climax Inc., of New York, has been appointed a director of Rhodesian Selection Trust, Ltd.

L. G. WHITE has resigned as manager of mines and exploration for Transcontinental Resources, Ltd., to join the Vancouver engineering staff of the Karl J. Springer interests.

RALPH EWING, chairman of the Climax Rock Drill and Engineering Works, Ltd., died suddenly in a London hospital on February 26, aged 67. Mr. Ewing served an engineering apprenticeship on the Clyde with Fullerton, Hodgart, and Barclay and was an Associate Member of the Institution of Mechanical Engineers. In 1913 he joined the technical sales staff of Climax, but during the 1914–1918 war he served as a lieutenant in France. In 1918 he rejoined the company, becoming a director in 1937 and in 1950, on the death of his brother Alfred, he succeeded him as chairman. When Holman Brothers, Ltd., acquired controlling interest in Climax in 1951 he continued as chairman and Mr. P. M. Holman became managing director. Mr. Ewing was one of the founder members of the British Compressed Air Society and was its third president in 1933.

INSTITUTION OF MINING AND METALLURGY

Elections and Transfers

February 13.

Member.— Jan BIERLING (*Salisbury, S. Rhodesia*); Archibald Thomas John DOLLAR, B.Sc., A.K.C. (*Sanderstead*); Donald MACLEOD, B.Sc. (*Kitwe*); Stephen William Kenneth MORGAN, A.R.S.M. (*Avonmouth*).

Associate Member to Member.—William DAVIES, M.Sc. (*Sheffield*); John Douglas STELLINGS, A.C.S.M. (*Perak*); Stanislaw Aleksander WROBEL, A.R.S.M., D.I.C., Ph.D. (*London*).

Associate Member.—Gordon CHAMBERS, B.Sc. (*St. Albans*); Albert William DAVIES, B.Sc. (*Jos*); Frank Fletcher ESPIE, B.E. (*Broken Hill, N.S.W.*); Horst Paul Ferdinand MATSCHKE (*Kitwe*); Thomas Clair MURPHY, A.C.S.M. (*Kuala Lumpur*); Alan William REECE, B.Sc. (*London*); Geoffrey George RUNNALLS, A.C.S.M. (*Luanshya*); Osmo Oiva VARTIAINEN, B.Sc. (*Kalalushi*); Arie VERMEY (*Dett, S. Rhodesia*); Robert Angus Munro WILSON, B.Sc. (*Nicosia*).

Student to Associate Member.—Charles Denzil ALEXANDER, B.Sc. (*Kitwe*); Brian Morris COLLINSON, A.R.S.M., B.Sc. (*Mufulira*); Edward DAVIES (*Mount Isa*); Bryan EARL, A.R.S.M. (*Glasgow*); Ronald Henry GEAR (*Luanshya*); Kenneth Edward Naish HANNAY (*Spragge, Ont.*); Laurence Pethick MARTIN, A.C.S.M. (*Bude*); Vincent Hugh Robert OLIVER, A.C.S.M. (*Mufulira*); Derek RHODES, B.Sc. (*Bancroft, Ont.*); Walter Theodore RUHMER, B.Sc. (*Welkom, O.F.S.*); Noel Roy SPENDLOVE, A.R.S.M., B.Sc. (*Doncaster*); George Rodney STILL, B.Sc. (*Maraisburg*); Roderick John TROLT, A.C.S.M. (*Nagpur*); Mohan Singh VIG, A.C.S.M. (*Nairobi*); John Keble WHITTINGHAM (*Dodoma*).

Affiliate.—Shridhar Rajaram MAHADKAR (*Camborne*).

Student.—Peter Anthony BEVAN (*Bedford*); David BRINKWORTH (*Camborne*); Aneuryn Keith CHANT, B.Sc. (*Carletonville*); Andries Cornelius COETZEE (*Johannesburg*); Gunvant Dattatraya DESHPANDE (*Camborne*); Otto Humphrey GILBERT, B.A., B.Sc. (*London*); Barré William GOLDIE (*Fleet*); Frederick William KIPLING (*Whitby*); William LOCAL (*Sherburn*); Brian Stanley MONK (*Romford*); Neil MORRIS (*Kidderminster*); Rex Anthony NASH (*Lincoln*); Arthur John PALLETT (*Camborne*); Michael Victor PAULL (*Truro*); Laurence Stephen PHILLIPS, B.Sc. (*London*);

Ian Michael PLUMMER, M.Sc. (*Nuneaton*); Vijay Krishnarao PURANIK, A.C.S.M. (*Stoke-on-Trent*); Peter Melvill SCOTT (*London*); Keith Dudley SHAW (*Lancing*); Arthur Walmsley SMITH (*Luton*); Robert Bruce SUTHERLAND (*Florida, Transvaal*); Albert John WATKINS (*Ross-on-Wye*); Richard John WHALE (*Newquay*); Edward Kojo-Esson WILLIAMS (*Camborne*); Brian Bailey YOUNG, A.R.S.M., B.Sc. (*Littlehampton*).

Metal Markets

During March [1]

Copper.—Although the market in copper has shown no great accession of strength during March, spasmodic bouts of firmness excepted, no new low price level was recorded. Various factors helped to alleviate slightly the gloom which has overhung the market for so long and prices [2] have been able to recover almost £20 per ton from the lowest post-war figure. Early in the month considerable attention was paid to the news that the Kennecott Copper Corporation was cutting output at its American facilities by 12%, news of particular significance coming as it did close on the heels of an announcement about reduced output by Phelps Dodge. However, most of the encouragement the market has had derived from European news.

In the U.S.A. information about the level of consumption has not been at all encouraging, while for non-American markets the question of the imposition of a duty on copper entering the U.S.A. has been an absorbing one. As has been noted before, a duty of 2 cents per lb. would be imposed as soon as the average U.S. domestic price had been at or under 24 cents per lb. for a month and when the custom smelters in the U.S.A. dipped to 23½ cents and then to 23 this prospect seemed imminent. However, speculative activity in America began to be evident not so much on the basis of the near-term 2 cent duty as on the prospects for a 4 cent duty provided by legislation in the summer. This, coupled with the arbitrage business that was still possible from London to New York, even on the 23 cents price and set against the background of a growing shortage of electrolytic wirebars in Europe, all lent strength to the Metal Exchange and prices there recovered, carrying with them the U.S. smelters' price to a level at which the immediate automatic duty became less likely.

There are still a good many ifs and buts about copper, the most important being the broad question of American consumption and the next probably the continued possibility of a legislated U.S. copper duty of 4 cents in the summer. There are, however, quite a few people who are prepared to suggest that copper at £160 again is not particularly likely in the foreseeable future. As this report is written a strike is due to become effective at the Chuquicamata mine in Chile, which should also help sentiment.

January statistics of the U.K. copper industry show consumption at 46,437 tons of refined copper and 10,178 tons in copper and alloy scrap. Production was 14,836 tons of primary and secondary refined, lower than December. An increase of less than 1,000 tons in blister copper stocks was more than offset by a drop in refined stocks to 61,276 tons from 70,871 tons at the end of December.

Tin.—A good many market observers have continued to maintain throughout March that the stringent restrictions on tin exports and production imposed by the International Tin Agreement must eventually so reduce the supply of that metal that an improvement in price will ultimately ensue. It is further argued that when the turn does come there is little to stop prices shooting up to £780 per ton, at which level the Buffer Stock manager has authority to sell to prevent too precipitous a rise. All this, however, seems rather theoretical when the cash price is down to the minimum support level and still occasionally taxing the Buffer Stock's reserves and the outlook is considered so dim that there is actually a backwardation.[1]

Basically, the question is of a conflict of ideologies, open-market operators refusing to believe that a controlled market system can work even for a short time. In view of the vast sums already expended on the scheme by the various interested Governments, however, there is still a large body of informed and unbiased opinion that gives the Tin Agreement a reasonable life yet. A good deal may hinge on the statements made after the next meeting of the Council scheduled for April 29.

U.K. January tin consumption was 1,734 tons; production also showed an increase from December at 3,614 tons. Stocks held increased by almost 3,000 tons to 18,578 tons.

Lead.—There have not been any startlingly new factors in lead in March.[1] The market's long-standing bogey—the possible imposition of American duties—is still unresolved although it is now expected that an announcement in this connexion may be made by the Tariff Commission within a week or two. With London exhibiting a rather negative sort of steadiness it was rather surprising to hear on April 1 that the U.S. lead price had been reduced to 12 cents per lb. after a very long period of stability at 13 cents. A U.K. lead mine was closed in March.

U.K. January consumption of lead amounted to 29,607 tons with production of English refined lead 6,325 tons. Stocks fell by a matter of 2,000 tons in the month to 49,134 tons.

Zinc.—The statistical position of zinc on a global basis remains unsatisfactory and the statistics for U.S. industry in February were particularly disappointing. However, prices [1] in London have now gone about as far as they can go, bearing in mind that current levels are still below the reported cost of production for a good many mines. Prospects for an early recovery from current levels are, nevertheless, not good. Two particular factors are likely to make sentiment in connexion with zinc even less auspicious than it has been. The first is that the General Services Administration has announced that the U.S. Government is buying no more metal for the stockpile from domestic mine output as the long-term stockpile goal has been reached. It is true that the market had fairly fully discounted this development, but it is still a bear factor. The other point to be borne in mind is the lower lead price in the U.S.A., as fully equal justification could be found for a corresponding move in zinc.

U.K. January consumption was 27,473 tons and

[1] Recent prices, pp. 200, 240.
[2] See Table, p. 240.

[1] See Table, p. 240.

production 6,460 tons. Stocks moved down slightly to 43,308 tons.

Iron and Steel.—On March 31 the first general reduction in U.K. home steel prices since January, 1939, was made. The cuts, which affected most products, with the notable exceptions of pig-iron and stainless steel, were modest, ranging between 1% and 3%, but had been made possible by the fall in the landed cost of imported raw materials and reduced import requirements of the steel industry. Unfortunately higher home costs, especially labour costs, reduced to some extent the gain resulting from the fall in overseas scrap and ore prices and freights. Under the Iron and Steel Board's new price determination light sections and bars, for instance, are down 7s. 6d. per ton; plates and heavy sections 10s. a ton and strip mill sheets by £1 a ton.

It is unlikely that the reductions will give any noticeable impetus to steel consumption, but the move is certainly an anti-inflationary one and it is encouraging to see a major industry passing a saving in costs on to the consumer. Meanwhile difficult conditions lie ahead for the steel industry. Although home demand generally bears up quite well, and the call for plates and sheets in particular is very good, reduced needs of overseas buyers has meant a decline in U.K. exports. February shipments were the lowest for five months at 228,608 tons and it now seems very unlikely that total exports this year will beat the 1957 level as was hoped earlier. Imports continue to shrink as works here becoming increasingly able to meet consumers' needs and outstanding contracts are completed and in February they totalled only 77,371 tons, the lowest for three years. Imports will probably decline still further in the coming months and will comprise mainly plates and sheets.

Iron Ore.—Imports of iron ore into the U.K. are maintained at a high level, the total for the first two months of 1958 being 2,296,813 tons, against 1,863,663 tons in January–February, 1957.

Aluminium.—On March 28 Aluminium, Ltd., announced a cut in primary aluminium prices in all its markets, effective April 1. In the United Kingdom this move brought the price to £180 per ton delivered. The reduction did not come as much of a surprise in this country, where the majority of consumers, being disappointed at the New Year, transferred their attention to April 1 as being the the most likely date for a price alteration. The new price is at about the same level as that at which Russian metal has been and is being sold in this country and it will be interesting to see what steps will be taken by the Russians to compete with the new price. It has been reported that the Russian intention is to keep some £10 a ton below the Canadian price which would mean a Russian quotation of £170 a ton. There is also the question of an anti-dumping duty against material from Russia which would further cut the Russian suppliers' returns, although at present it is generally thought that the duty is less likely to be imposed than it was prior to the price reduction.

Antimony.—On March 21 a Treasury Order came into effect which increased the duty on imported antimony metal and oxides to 25% or £40 a ton, whichever is the larger. Previous to this the duty on foreign material was 10%, except on oxides classed as pigments, which were liable to a 20% duty. As yet it has not been possible to assess with any degree of accuracy the effect which this new duty will have on foreign producers, although it seems fairly obvious that they will have to reduce their prices in order to be able to compete with the U.K. price and the added advantage of speedier delivery.

The price of English regulus remains unchanged at £197 10s. a ton for 99·6% material.

Arsenic.—There is still no change to report in the arsenic market and conditions remain quiet with the usual amount of business passing. Arsenic metal is still quoted at £400 a ton and trioxide at £45 a ton; imports during February totalled 601 tons, bringing the total for the first two months of this year to 1,051 tons.

Bismuth.—There have been no changes to record during March in this market and the price is still quoted at 16s. a lb. Imports of metal during February totalled 32,686 lb., only half the amount imported into the U.K. in the same month of 1957.

Cobalt.—U.K. cobalt prices remained unaltered during March with metal at 16s. per lb., black oxide 10s. 5d. per lb., and grey oxide 11s. per lb. delivered. The overall market position remains unchanged with a surplus of production over consumption. Imports of cobalt metal in February totalled almost 12,000 lb.

Cadmium.—After the excitement of previous months the cadmium market in the U.K. seems to have settled down at the 10s. a lb. level for U.K. and Empire metal. While, as mentioned in our previous report, the cheaper material on the Continent indicates competition from that source is still possible there were no signs of this competition during the past month. Imports during February were 113,119 lb.

Chromium.—The price of chromium metal in the United Kingdom is still quoted at 6s. 11d. to 7s. 4d. per lb. and although there has been competition from Soviet ferro-chrome this has not been paralleled in the metal.

Tantalum.—The month of March brought no new factors into the tantalite market, neither did it do anything to clarify the somewhat confused position which exists. As we mentioned in our last report there are two different schools of thought about this market and as yet it is not clear as to which of these is thinking correctly. The price in the U.K. remains unchanged at 900s. to 1,000s. per unit for 60% ore.

Platinum.—Following the fall in the price of platinum—*i.e.*, U.K. and Empire produced material—to £26 15s. per troy oz. it is once again rumoured that there is yet another decline looming in the not too distant future. Open-market prices continued to ease during the month and latest indications are around the £23 10s. per troy oz. level. Interest in platinum is virtually non-existent and it has been suggested that March saw the lowest level of business for some time past.

Iridium.—Once again this market has remained featureless during a period of very little business in any of the platinum-group metals. The price is still quoted nominally at £25 to £27 a troy oz.

Osmium.—As with iridium the past month has been one of dullness and inactivity for osmium; the price is unaltered at £22 to £25 per troy oz. per troy oz.

Palladium.—In conformity with other platinum metals palladium remained dull during March with little buying interest being displayed. This metal remains unchanged in price at £7 10s. per oz.

Imports of platinum metals into the U.K. during

February amounted to 15,404 troy oz., a fall of some 5,000 oz. from the previous month's total.

Tellurium.—The price of tellurium remained at between 15s. and 16s. per lb. during March; no untoward events disturbed this usually uninteresting market.

Tungsten.—During March tungsten continued its downward trend with no signs of any let-up in the near future. Stocks held in merchants' hands in Europe alone are sufficient to keep the market supplied for a considerable time at the present rate of demand. In fact it is understood that such stocks are largely the same as they were at the end of 1957. As noted in the last report the outlook for tungsten remains obscure and something of a tug-of-war between buyers and sellers may ensue.

The price is now quoted at 90s. to 95s. per long ton unit of WO_3.

Nickel.—Towards the latter half of March the International Nickel Co. of Canada announced that it was cutting back its nickel production in Canada by 10% immediately. While this move was unexpected it did not cause a great deal of surprise for, as has been mentioned many times previously, world production is running ahead of the total market demand as well as consumption. In addition to this cut the company has said that unless there is a business up-turn in Canada and the U.S.A. in the near future a further production cut may become necessary. Despite the long-term Inco price stability policy there are doubtless some consumers hoping for a lowering of the price of Canadian metal and in consequence consumers are likely to curtail their buying and keep stocks down to a minimum.

Ingots in the U.K. are still quoted at £600 a ton.

Chromium.—Further to the note in our previous report regarding the Turkish mineral credit bank it is understood that it has now begun operations. An organization with the title of Krom-Ischlemtesi AO is representing the interests of chrome mine owners within the bank. The object of the bank is to lower exploration and transport costs to Turkish mines, thereby improving the export potential of the country's ore.

The overall chrome ore position remains unchanged with not much interest being displayed by consumers. Rhodesian ore is quoted at £17 5s. a ton c.i.f.

Molybdenum.—With the easier supply position of molybdenite continuing the American Metal Climax concern late in March placed its Climax mine on a short week. The company's stocks of ore have risen to 5,700 tons of Mo and daily production recently has been in the region of 33,500 tons of ore. In spite of the easier supply position the price remains at 8s. 5d. per lb. of Mo, f.o.b. Climax, Colorado.

Manganese.—During March the manganese market was virtually totally inactive. Excluding contract business nothing moved so that despite sellers not seeming anxious to sell and the current weakness in freight rates the European c.i.f. price fell to 102d. to 106d. per unit of Mn. Despite this fall buyers are not showing any interest due to the fact that they are, in the main, fully bought for the next few months' needs. In fact, it is generally thought that consumers' needs for 1958 are already completely filled by stocks and contracts already entered into.

Tin, Copper, Lead, and Zinc Markets

Tin, minimum, 99·75%; Copper, electro; Lead, minimum 99·75%; and Zinc, minimum 98%, per ton.

Date		Tin		Copper		Lead		Zinc	
		Settlement	3 Months	Spot	3 Months	Spot	3 Months	Spot	3 Months
		£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.
Mar.	11	732 0	738 10	165 7½	167 12½	74 11¼	74 2½	63 2½	63 7½
	12	732 0	736 5	166 17½	169 2½	74 13¾	74 8¾	63 0	63 7½
	13	731 10	736 10	164 17½	167 2½	74 10	74 3¾	62 18¾	63 6¼
	14	732 10	738 10	167 15	169 7½	74 11¼	74 11¼	63 6¼	63 13¾
	17	731 0	736 15	169 12½	171 7½	75 2½	74 18¾	63 17½	63 17½
	18	730 10	736 5	173 5	171 15	75 2½	75 0	63 17½	63 17½
	19	730 10	733 10	168 7½	169 2½	74 16¼	74 13¾	63 8¾	63 11¼
	20	730 10	733 10	174 7½	174 7½	75 15	75 7½	64 1¼	64 3¾
	21	730 10	734 5	174 2½	174 17½	75 7½	75 2½	63 12½	63 13½
	24	730 10	733 15	178 2½	178 12½	75 16¼	75 13¾	63 17½	64 2½
	25	730 10	733 0	178 5	178 12½	75 11¼	75 8¾	63 13¾	63 13¾
	26	730 10	732 5	176 5	176 12½	75 2½	74 18¾	63 16¼	63 16¼
	27	730 10	731 5	178 2½	177 17½	74 18¾	74 18¾	63 18¾	63 18¾
	28	730 10	730 15	176 12½	176 12½	73 15	73 15	63 3¾	63 2½
	31	730 10	729 10	178 17½	178 17½	73 13¾	73 12½	63 18¾	63 12½
Apr.	1	730 10	724 15	179 7½	179 17½	73 18¾	73 18¾	63 6¼	63 2½
	2	730 10	722 15	176 12½	176 17½	72 2½	72 2½	61 17½	61 17½
	3	731 10	728 5	175 12½	175 17½	72 7½	72 7½	62 7½	62 2½
	4	—	—	—	—	—	—	—	—
	7	—	—	—	—	—	—	—	—
	8	731 10	727 5	171 12½	173 2½	71 12½	71 12½	61 13¾	62 13¾
	9	733 10	729 15	173 5	173 17½	71 17½	72 2½	62 2½	62 2½

Statistics

TRANSVAAL AND O.F.S. GOLD OUTPUTS

	February		March	
	Treated Tons.	Yield Oz.*	Treated Tons.	Yield Oz.†
Blyvooruitzicht	99,000	57,603	107,000	61,870
Brakpan	110,000	15,366	124,000	16,415
Buffelsfontein‡	106,000	35,182	109,000	36,123
City Deep	137,000	26,112	146,000	27,957
Cons. Main Reef	124,000	20,344	142,000	21,805
Crown Mines	209,000	32,623	236,000	35,573
Daggafontein	209,000	44,205	226,000	47,462
Doornfontein‡	83,000	34,507	86,000	35,841
D'rb'n Roodeport Deep	165,000	29,866	181,000	32,727
East Champ D'Or‡	11,500	304	12,000	294
East Daggafontein	84,500	14,006	91,000	15,123
East Geduld	115,000	35,364	126,000	38,745
East Rand P.M.	202,000	52,572	223,000	57,586
Eastern Transvaal Consol	17,700	5,943	18,200	6,279
Ellaton‡	30,000	6,831	32,000	7,520
Freddies Consol.	47,000	15,510	47,000	15,805
Free State Geduld	62,000	45,266	66,000	47,360
Geduld	77,000	12,144	80,000	12,596
Government G.M. Areas‡	60,000	10,727	62,000	10,549
Grootvlei Proprietary	180,000	38,426	195,000	41,544
Harmony Gold Mining	73,000	29,959	78,000	31,870
Hartebeestfontein‡	80,000	44,000	83,000	45,235
Libanon	99,000	22,744	100,000	22,926
Loraine	62,000	11,254	67,000	12,179
Luipaards Vlei‡	111,000	13,025	120,000	14,206
Marievale Consolidated	66,000	17,392	72,000	18,900
Merriespruit‡	—	—	—	—
Modderfontein East	121,000	12,327	137,000	13,184
New Kleinfontein	86,000	10,645	96,000	11,426
New Klerksdorp‡	11,200	1,045	10,900	1,258
President Brand	75,000	55,323	79,500	58,618
President Steyn	90,000	34,587	94,000	36,083
Rand Leases	150,000	22,725	158,000	23,858
Randfontein‡	162,000	13,984	180,000	15,687
Rietfontein Consolid't'd.	21,500	5,004	21,500	5,021
Robinson Deep	70,000	14,900	71,000	15,194
Rose Deep	53,000	7,445	60,000	8,148
St. Helena Gold Mines	108,000	32,244	113,000	33,309
Simmer and Jack	77,000	15,932	80,000	15,995
S. African Land and Ex.	81,000	16,874	89,000	18,101
S. Roodepoort M.R.	27,000	6,460	29,000	6,926
Spaarwater Gold	10,330	3,219	10,700	3,291
Springs	119,000	13,189	127,000	14,100
Stilfontein Gold Mining‡	107,000	53,125	110,000	54,543
Sub Nigel	64,000	15,546	66,500	16,462
Transvaal G.M. Estates	16,400	2,585	—	—
Vaal Reefs‡	63,000	28,352	69,000	31,050
Van Dyk Consolidated	71,000	12,580	76,000	13,700
Venterspost Gold	113,000	27,855	122,000	28,994
Village Main Reef	27,000	4,581	27,000	4,692
Virginia O.F.S.‡	98,000	25,480	92,000	24,406
Vlakfontein	48,000	16,951	49,500	17,461
Vogelstruisbult‡	96,000	21,811	96,000	21,589
Welkom Gold Mining	81,000	24,104	85,000	24,888
West Driefontein‡	75,000	72,132	77,000	73,780
West Rand Consol. ‡	190,000	19,751	212,000	21,580
Western Holdings	91,000	48,940	96,000	52,274
Western Reefs	106,000	24,649	112,500	26,213
Witwatersrand Nigel	17,200	4,255	17,600	4,346

† 248s. 4d. * 248s. 9d. ‡ Gold and Uranium.

COST AND PROFIT IN THE UNION

	Tons milled	Yield per ton	Work'g cost per ton	Work'g profit per ton	Total working profit
		s. d.	s. d.	s. d.	£
Dec. 1956	16,444,200	59 8	44 5	15 3	19,449,432
Jan., 1957	—	—	—	—	—
Feb.	—	—	—	—	—
Mar.	16,430,800	60 8	44 8	16 0	20,657,462
April	—	—	—	—	—
May	—	—	—	—	—
June*	16,785,200	62 4	45 1	17 3	22,595,371
July	—	—	—	—	—
August	—	—	—	—	—
Sept.*	15,699,900	64 0	45 6	17 3	24,193,575
Oct.	—	—	—	—	—
Nov.	—	—	—	—	—
Dec.	16,198,500	64 4	46 1	18 3	23,695,380

* 3 Months.

PRODUCTION OF GOLD IN SOUTH AFRICA

	Rand and O.F.S.	Outside	Total
	Oz.	Oz.	Oz.
March, 1957	1,288,140	38,765	1,405,422
April	1,366,657	36,979	1,398,667
May	1,361,688	45,361	1,450,668
June	1,405,307	24,957	1,420,021
July	1,395,064	53,099	1,479,439
August	1,426,340	38,941	1,459,794
September	1,400,745	37,611	1,438,356
October	1,416,211	39,996	1,456,207
November	1,386,047	36,470	1,422,517
December	1,366,354	35,789	1,402,143
January, 1958	1,377,505	40,534	1,418,039
February	1,322,843	33,879	1,356,722

NATIVES EMPLOYED IN THE SOUTH AFRICAN MINES

	Gold Mines	Coal Mines	Total
June 30, 1957	335,756	29,411	371,105
July 31	329,142	29,083	365,167
August 31	322,847	28,604	351,451
September 30	315,955	28,170	344,125
October 31	310,428	28,020	338,448
November 30	305,104	27,619	332,723
December 31	299,137	27,623	326,760
January 31, 1958	314,239	28,489	342,728
February 28	326,885	30,227	357,112

MISCELLANEOUS METAL OUTPUTS

	4-Week Period To Mar. 9		
	Tons Ore	Lead Concs. tons	Zinc Concs. tons
Broken Hill South	27,920	3,909	4,948
Electrolytic Zinc	14,298	760	4,282
Lake George	18,050	1,717	3,159
Mount Isa Mines**	54,578	3,415†	2,770
New Broken Hill	—	—	—
North Broken Hill	30,496	5,878	5,825
Zinc Corp.	—	—	—
Rhodesia Broken Hill*	—	—	—

* 3 Mths. ** Copper 2,000 tons. † Metal.

RHODESIAN GOLD OUTPUTS

	February		March	
	Tons	Oz.	Tons	Oz.
Cam and Motor	30,584	9,748	—	—
Falcon Mines	20,000	3,850	21,920	4,015
Globe and Phœnix	5,300	3,308	6,200	3,669
Motapa Gold Mining	12,400	1,834	—	—
Mazoe	2,790	903	—	—
Coronation Syndicate	10,658	4,217	—	—

WEST AFRICAN GOLD OUTPUTS

	February		March	
	Tons	Oz.	Tons	Oz.
Amalgamated Banket	60,969	15,205	63,171	14,855
Ariston Gold Mines	40,730	11,930	43,600	11,991
Ashanti Goldfields	30,000	25,000	—	—
Bibiani	35,000	6,900	35,000	6,900
Bremang	—	4,407	—	4,602
Ghana Main Reef	11,816	4,203	11,315	4,172
Konongo	5,550	3,980	5,630	4,040
Lyndhurst	—	—	—	—
Marlu	—	—	—	—
Nanwa	—	—	—	—
Taquah and Abosso	—	—	—	—

PRODUCTION OF GOLD AND SILVER IN RHODESIA

	1956		1957	
	Gold (oz.)	Silver (oz.)	Gold (oz.)	Silver (oz.)
January	44,619	5,841	44,337	6,134
February	41,858	5,347	41,607	5,697
March	43,799	5,543	43,831	8,179
April	46,577	6,346	46,754	6,854
May	45,822	7,891	42,650	5,606
June	45,996	6,838	46,682	6,441
July	46,178	7,084	41,922	5,781
August	46,427	6,531	44,001	5,897
September	44,654	6,400	45,762	5,677
October	44,486	6,473	46,838	5,570
November	42,648	6,599	46,987	6,331
December	43,327	6,008	45,479	5,814

WESTRALIAN GOLD PRODUCTION

	1956	1957	1958
	Oz.	Oz.	Oz.
January	66,388	106,722	66,562
February	94,638	64,949	65,905
March	66,944	67,121	—
April	60,415	66,435	—
May	62,204	64,886	—
June	63,570	65,142	—
July	69,883	74,420	—
August	72,303	75,727	—
September	62,204	64,422	—
October	64,594	64,524	—
November	64,113	65,700	—
December	65,031	66,562	—
Total	812,377	846,610	842,004

AUSTRALIAN GOLD OUTPUTS

	4-Week Period			
	To Feb. 18		To Mar. 18	
	Tons	Oz.	Tons	Oz.
Boulder Perseverance	—	—	—	—
Central Norseman	13,682	8,198	14,006	8,786
Cœsus Proprietary	—	—	—	—
Gold Mines of Kalgoorlie	40,354	11,997	39,811	12,428
Golden Horse Shoe*	—	—	—	—
Gt. Boulder Prop.*	—	—	—	—
Gt. Western Consolidated	42,844	6,212	40,005	6,250
Kalgoorlie Enterprise	—	—	—	—
Kalgurli Ore Treatment	—	—	—	—
Lake View and Star*	—	—	—	—
Moonlight Wiluna*	—	—	—	—
Morning Star (G.M.A.)	—	—	—	—
Mount Ida	—	—	—	—
New Coolgardie	—	—	—	—
North Kalgurli	26,556	5,269	26,214	5,605
Sons of Gwalia	11,714	2,453	—	—
South Kalgurli	—	—	—	—
Mount Morgan	—	3,542	—	3,208

* 3 Months.

ONTARIO GOLD AND SILVER OUTPUT

	Tons Milled	Gold Oz.	Silver Oz.	Value Canad'n $
October, 1956	754,191	212,490	34,854	7,159,732
November	747,059	209,797	34,135	7,102,110
December	741,525	213,846	60,129	7,180,865
Jan., 1957	759,681	210,404	33,082	7,114,391
February	702,636	197,225	32,199	6,635,527
March	793,674	215,830	35,787	7,250,018
April	771,608	216,457	35,685	7,314,450
May	790,159	222,436	37,241	7,509,638
June	738,384	207,897	32,544	6,945,127
July	718,468	198,620	30,620	6,572,323
August	701,174	192,453	31,647	6,410,429
September	722,384	205,471	34,248	6,947,813
October	772,383	224,217	37,086	7,657,426
November	756,494	219,352	37,737	7,441,702
December	750,537	215,462	44,230	7,494,289
January, 1958	779,128	219,502	31,562	7,462,598

MISCELLANEOUS GOLD AND SILVER OUTPUTS

	Feb.		Mar.	
	Tons	Oz.	Tons	Oz.
British Guiana Cons.	—	1,068	—	—
Central Victoria Dredging	—	—	—	—
Clutha River	—	464	—	421
Emperor Mines (Fiji)*	45,207	15,430	—	—
Frontino Gold (Colombia)	—	—	—	—
Geita Gold (Tanganyika)	23,000	3,339	—	—
Harrietville (Aust.)	—	—	—	—
Lampa (Peru)†	—	32,336	—	—
Loloma (Fiji)*	—	—	—	—
New Guinea Goldfields	3,123	1,065	—	—
St. John d'el Rey (Brazil)	23,000	£108,000	—	—
Yukon Consol.	—	—	—	—

* 3 Months. † Ozs. Silver : 58½ tons copper.

OUTPUTS OF MALAYAN TIN COMPANIES IN LONG TONS OF CONCENTRATES

	Jan.	Feb.	Mar.
Ampat Tin	60½	60	68½
Austral Amalgamated	—	—	—
Ayer Hitam	—	—	—
Batu Selangor	—	—	—
Berjuntai	121	79	178½
Chenderiang	—	—	—
Gopeng Consolidated	—	—	—
Hongkong Tin	—	—	—
Idris Hydraulic	—	—	—
Ipoh	—	—	—
Jelapang Tin	—	—	—
Kampong Lanjut	98	70	69
Kamunting	38½	59½	82½
Kent (F.M.S.)	—	—	—
Kepong	—	—	—
Killinghall	—	—	—
Kinta Kellas	—	—	—
Kinta Tin Mines	—	—	—
Klang River	—	—	—
Kramat	47½	41	45
Kuala Kampar	87	74	100
Kuala Lumpur	—	—	—
Kuchai	—	—	—
Lahat Mines	—	—	—
Larut	28	20	37
Lower Perak	124½	137	149
Malayan	—	—	—
Malaysiam	9	5½	—
Pacific Tin Consolidated	—	—	—
Pahang Consolidated	135	—	—
Pengkalen	—	—	—
Petaling Tin	—	—	—
Puket	—	—	—
Rahman Hydraulic	—	—	—
Rambutan	—	—	—
Rantau	54½	43½	65
Rawang Concessions	—	—	—
Rawang Tin Fields	—	—	—
Renong	—	—	—
Selayang	—	—	—
Siamese Tin Syndicate (Malaya)	33	10½	—
Southern Kinta	248	305	353
Southern Malayan	—	—	—
Southern Tronoh	—	—	—
Sungei Besi	—	—	—
Sungei Kinta	—	—	—
Sungei Way	—	—	—
Taiping Consolidated	54	39	41
Tambah	—	—	—
Tanjong	—	—	—
Tekka	—	—	—
Tekka-Taiping	30	16	—
Temoh	—	—	—
Tongkah Compound	—	—	—
Tongkah Harbour	26½	26½	—
Tronoh	—	—	—
Ulu Klang	—	—	—

MISCELLANEOUS TIN COMPANIES' OUTPUTS IN LONG TONS OF CONCENTRATES

	Feb.		Mar.	
	Tin	Columbite	Tin	Columbite
Amalgamated Tin Mines ..	393	39	279½	—
Anglo-Burma Tin	20	—	63*	—
Bangrin	42	—	—	—
Beralt	40	120†	53	107†
Bisichi	78½	10	67½	8½
Ex-Lands Nigeria	37	—	44	—
Geevor	55	—	—	—
Gold and Base Metal	43	—	—	—
Jantar Nigeria	28	20	—	—
Jos Tin	15	—	—	—
Kaduna Prospectors	6½	—	7	—
Kaduna Syndicate	25	—	35	—
Katu Tin	21	—	—	—
Kelti Tin	—	—	—	—
London Nigerian Mines ...	—	—	—	—
Naraguta Extended	—	—	—	—
Naraguta Karama	—	—	—	—
Naraguta Tin	—	—	—	—
Renong Consolidated	17	—	—	—
Ribon Valley (Nigeria) ...	14	½	—	—
Siamese Tin Syndicate	62	—	—	—
South Bukeru	—	—	—	—
South Crofty	56	—	59	—
Tavoy Tin	10½	—	11	—
Thabawleik	—	—	—	—
Tin Fields of Nigeria	—	—	—	—
United Tin Areas of Nigeria	4	½	—	—

* 3 months † Wolfram.

SOUTH AFRICAN MINERAL OUTPUT

January, 1958

Gold	1,415,780 oz.
Silver	137,590 oz.
Diamonds	369,656 carats.*
Coal	3,426,021 tons.
Copper	(*a*) 250 tons in matte and copper-gold concentrates. (*b*) 4,312 tons of 99·38%.
Tin	289 tons concs.
Platinum (concentrates, etc.)	—
Platinum (crude)	—
Asbestos	12,382 tons.
Chrome Ore	59,063 tons.
Manganese Ore	64,039 tons.
Lead Concs.	— tons.

* Dec., 1957.

IMPORTS OF ORES, METALS, ETC., INTO UNITED KINGDOM

		Jan.	Feb.
Iron Ore	tons	1,276,115	1,020,608
Manganese Ore	,,	46,121	25,482
Iron and Steel	,,	96,598	77,371
Iron Pyrites	,,	15,755	24,218
Copper Metal	,,	32,878	44,536
Tin Ore	,,	9,145	8,798
Tin Metal	,,	2,335	2,435
Lead	,,	15,858	14,211
Zinc Ore and Conc.	,,	26,743	16,182
Zinc	,,	10,136	13,279
Tungsten Ores	,,	313	196
Chrome Ore	,,	15,783	19,555
Bauxite	,,	46,300	14,100
Antimony Ore and Concs.	,,	379	303
Titanium Ore	,,	36,966	40,321
Nickel Ore	,,	2,896	2,914
Tantalite/Columbite	,,	18	63
Sulphur	,,	28,758	11,924
Barytes	,,	4,894	5,592
Asbestos	,,	6,883	7,726
Magnesite	,,	3,545	4,287
Mica	,,	200	301
Graphite	,,	306	135
Mineral Phosphates	,,	83,609	91,725
Molybdenum Ore	,,	474	228
Nickel	cwt.	32,847	8,055
Aluminium	,,	292,317	50,920
Mercury	lb.	53,841	238,552
Bismuth	,,	96,673	32,686
Cadmium	,,	85,031	113,199
Cobalt and Cobalt Alloys	,,	81,025	11,886
Selenium	,,	2,897	10,664
Petroleum Motor Spirit ...	1,000 gals.	55,914	55,749
,, Crude	,,	672,892	645,213

Prices of Chemicals

The figures given below represent the latest available.

		£	s.	d.
Acetic Acid, Glacial	per ton	106	0	0
,, ,, 80% Technical	,,	97	0	0
Alum, Comml.	,,	25	0	0
Aluminium Sulphate	,,	16	10	0
Ammonia, Anhydrous	per lb.		2	0
Ammonium Carbonate	per ton	59	0	0
,, Chloride, 98%	,,	26	0	0
,, Phosphate (Mono- and Di-) ...	,,	102	0	0
Antimony Sulphide, golden	per lb.		3	0
Arsenic, White, 99/100%	per ton	47	10	0
Barium Carbonate (native), 94%	,,	Nominal		
,, Chloride	,,	53	0	0
Barytes (Bleached)	,,	20	0	0
Benzole	per gal.		5	2
Bleaching Powder, 36% Cl.	per ton	30	7	6
Borax	,,	44	0	0
Boric Acid, Comml.	,,	73	10	0
Calcium Carbide	,,	40	17	9
,, Chloride, solid, 70/75%	,,	12	10	0
Carbolic Acid, crude 60's	per gal.		8	3
Carbon Bisulphide	per ton	62	10	0
Chromic Acid (ton lots)	per lb.		2	2½
Citric Acid	per cwt.	10	15	0
Copper Sulphate	per ton	67	0	0
Creosote Oil (f.o.r. in Bulk)	per gal.		1	1
Cresylic Acid, 97-98%	,,		6	6
Hydrochloric Acid 28° Tw.	per carboy		13	0
Hydrofluoric Acid, 59/60%	per lb.		1	1
Iron Sulphate	per ton	3	17	6
Lead, Acetate, white	,,	124	0	0
,, Nitrate	,,	116	0	0
,, Oxide, Litharge	,,	110	10	0
,, Red	,,	106	15	0
,, White	,,	104	15	0
Lime, Acetate, brown	,,	40	0	0
Magnesite, Calcined	,,	20	0	0
,, Raw	,,	9	0	0
Magnesium Chloride, ex W'h'se	,,	16	0	0
,, Sulphate, Comml.	,,	15	10	0
Methylated Spirit, Industrial, 66 O.P.	per gal.		6	3
Nitric Acid, 80° Tw.	per ton	37	10	0
Oxalic Acid	,,	129	0	0
Phosphoric Acid (S.G. 1·750)	per lb.		1	4
Pine Oil	per ton	Nominal		
Potassium Bichromate	per lb.		1	2½
,, Carbonate (hydrated)	per ton	74	10	0
,, Chloride, 96%	,,	21	0	0
,, Iodide	per lb.		9	0
,, Amyl Xanthate	,,	Nominal		
,, Ethyl Xanthate	,,	Nominal		
,, Hydrate (Caustic) solid	per ton	118	0	0
,, Nitrate	per cwt.	4	1	0
,, Permanganate	per ton	193	10	0
,, Sulphate, 48%	,,	22	6	0
Sodium Acetate	,,	99	0	0
,, Arsenate, 58-60%	,,	Nominal		
,, Bicarbonate	,,	15	0	0
,, Bichromate	per lb.		1	0
,, Carbonate (crystals)	per ton	Nominal		
,, ,, (Soda Ash) 58%	,,	13	10	0
,, Chlorate	,,	90	0	0
,, Cyanide 100% NaCN basis	per cwt.	6	6	6
,, Hydrate, 76/77%, solid	per ton	33	0	0
,, Hyposulphite, Comml.	,,	32	15	0
,, Nitrate, Comml.	,,	29	10	0
,, Phosphate (Dibasic)	,,	40	10	0
,, Prussiate	per lb.		1	0½
,, Silicate	per ton	11	0	0
,, Sulphate (Glauber's Salt)	,,	9	15	0
,, ,, (Salt-Cake)	,,	8	0	0
,, Sulphide, flakes, 60/62%	,,	37	2	6
,, Sulphite, Comml.	,,	27	10	0
Sulphur, American, Rock (Truckload)	,,	17	0	0
,, Ground, Crude	,,	19	0	0
Sulphuric Acid, 168° Tw.	,,	10	15	0
,, ,, free from Arsenic, 140° Tw.	,,	8	3	0
Superphosphate of Lime, 18% P_2O_5	,,	14	16	0
Tin Oxide	,,	Nominal		
Titanium Oxide, Rutile	,,	177	0	0
,, White, 25%	,,	83	10	0
Zinc Chloride	,,	Nominal		
,, Dust, 95/97% (4-ton lots)	,,	104	0	0
,, Oxide	,,	88	0	0
,, Sulphate	,,	32	0	0

Share Quotations

Shares of £1 par value except where otherwise stated.

GOLD AND SILVER:	Mar. 10, 1958 £ s. d.	Apr. 8, 1958 £ s. d.
SOUTH AFRICA:		
Blinkpoort (5s.)	2 0 0	1 19 3
Blyvooruitzicht (2s. 6d.)	1 0 6	1 1 6
Brakpan (5s.)	5 0	4 9
Buffelsfontein (10s.)	1 17 9	1 19 6
City Deep	13 6	14 0
Consolidated Main Reef	12 3	15 6
Crown Mines (10s.)	1 1 6	1 4 0
Daggafontein (5s.)	1 8 3	1 10 0
Dominion Reefs (Ord. 5s.)	12 6	13 0
Doornfontein (10s.)	1 3 6	1 4 0
Durban Roodepoort Deep (10s.)	1 8 3	1 9 3
East Champ d'Or (2s. 6d.)	2 3	2 3
East Daggafontein (10s.)	8 9	9 0
East Geduld (4s.)	1 3 0	1 4 6
East Rand Proprietary (10s.)	2 1 3	2 2 6
Freddies Consol	3 0	3 0
Free State Dev. (5s.)	4 6	4 3
Free State Geduld (5s.)	4 1 0	4 0 9
Free State Saaiplaas (10s.)	13 0	11 6
Geduld	3 1 3	3 1 9
Government Gold Mining Areas (5s.)	3 6	3 6
Grootvlei (5s.)	15 0	15 6
Harmony (5s.)	1 12 9	1 14 6
Hartebeestfontein (10s.)	2 17 6	2 19 0
Libanon (10s.)	7 6	7 6
Loraine (10s.)	2 6	2 0
Luipaards Vlei (2s.)	11 0	11 0
Marievale (10s.)	18 3	18 3
Merriespruit (5s.)	4 0	4 6
Modderfontein B (3d.)	2 0	2 0
Modderfontein East	12 0	13 6
New Kleinfontein	3 9	4 3
New Pioneer (5s.)	1 8 3	1 9 6
New State Areas (10s.)	1 3	2 0
President Brand (5s.)	2 9 3	2 9 6
President Steyn (5s.)	1 8 9	1 8 3
Rand Leases (10s.)	4 3	4 6
Randfontein	1 7 0	1 7 3
Riebeeck (10s.)	11 3	10 6
Rietfontein (5s.)	8 0	8 6
Robinson Deep (7s. 6d.)	7 3	9 0
Rose Deep (9s. 6d.)	10 6	11 6
St. Helena (10s.)	1 18 6	2 2 3
Simmer and Jack (2s. 6d.)	4 0	4 3
South African Land (3s. 6d.)	1 1 6	1 1 3
Springs (5s.)	2 0	2 0
Stilfontein (5s.)	1 17 9	1 19 6
Sub Nigel (10s.)	12 0	13 9
Vaal Reefs (5s.)	1 17 6	1 19 6
Van Dyk (9s.)	3 6	4 0
Venterspost (10s.)	14 3	14 0
Virginia (5s.)	7 9	8 3
Vlakfontein (10s.)	15 6	16 0
Vogelstruisbult (10s.)	9 9	9 6
Welkom (5s.)	14 3	13 9
West Driefontein (10s.)	4 11 3	4 12 3
West Rand Consolidated (10s.)	1 4 9	1 5 6
West Witwatersrand Areas (2s. 6d.)	1 19 9	1 19 6
Western Holdings (5s.)	4 11 3	4 11 3
Western Reefs (5s.)	1 6 6	1 6 0
Winkelhaak (10s.)	16 9	17 3
Witwatersrand Nigel (2s. 6d.)	1 3	1 3
RHODESIA:		
Cam and Motor (2s. 6d.)	8 3	8 0
Chicago-Gaika (10s.)	13 9	15 0
Coronation (2s. 6d.)	3 9	3 6
Falcon (5s.)	7 0	6 9
Globe and Phœnix (5s.)	1 4 9	1 5 6
Motapa (5s.)	6	6
GOLD COAST:		
Amalgamated Banket (3s.)	1 3	1 3
Ariston Gold (2s. 6d.)	4 6	4 0
Ashanti Goldfields (4s.)	13 0	13 3
Bibiani (4s.)	2 3	2 0
Bremang Gold Dredging (5s)	1 9	1 6
Ghana Main Reef (5s.)	1 9	1 6
Konongo (2s.)	2 0	1 6
Kwahu (2s.)	2 6	2 3
Taquah and Abosso (3s.)	6	6
Western Selection (5s.)	4 9	4 6
AUSTRALASIA:		
Gold Fields Aust. Dev. (3s.), W.A.	2 0	2 0
Gold Mines of Kalgoorlie (10s.)	9 3	9 3
Great Boulder Propriet'y (2s.), W.A.	12 3	12 0
Lake View and Star (4s.), W.A.	1 0 6	1 1 6
London-Australian (2s.)	9	9
Mount Morgan (10s.), Q.	6 9	6 9
New Guinea Gold (4s. 3d.)	1 3	1 6
North Kalgurli (1912) (2s.), W.A.	7 3	7 6
Sons of Gwalia (10s.), W.A.	2 0	2 3
Western Mining (5s.), W.A.	8 0	8 0

	Mar. 10, 1958 £ s. d.	Apr. 8, 1958 £ s. d.
MISCELLANEOUS:		
Fresnillo ($1·00)	2 4 6	2 5 0
Kentan Gold Areas (1s.), E. Africa	3	4
St. John d'el Rey, Brazil	2 14 3	2 13 9
Yukon Consolidated ($1)	4 9	4 6
COPPER:		
Bancroft Mines (5s.), N. Rhodesia	15 0	14 6
Esperanza (2s. 6d.), Cyprus	1 2	1 2
Indian (2s.)	3 0	3 3
Magundi (5s.)	3 3	3 0
Messina (5s.), Transvaal	3 8 3	3 16 3
Mount Lyell, Tasmania	16 9	16 6
Nchanga Consolidated, N. Rhodesia	8 17 0	8 6 0
Rhokana Corporation, N. Rhodesia	22 10 0	24 5 0
Roan Antelope (5s.), N. Rhodesia	7 6	8 0
Tanganyika Concessions (10s.)	5 0 0	2 10 0
LEAD-ZINC:		
Broken Hill South (5s.), N.S.W.	2 16 3	2 19 6
Burma Mines (3s. 6d.)	1 9	1 6
Consol. Zinc Corp. Ord.	2 7 6	2 6 0
Electrolytic Zinc, Tasmania (Pref. 5s.)	2 12 6	2 12 6
Lake George (5s.), N.S.W.	3 6	3 6
Mount Isa, Queensland (5s. Aust.)	1 1 6	1 1 6
New Broken Hill (5s.), N.S.W.	1 12 6	1 12 6
North Broken Hill (5s.), N.S.W	3 17 6	3 16 0
Rhodesia Broken Hill (5s)	7 0	7 3
San Francisco (10s.), Mexico	14 3	14 6
TIN:		
Amalgamated Tin (5s.), Nigeria	5 6	5 3
Ampat (4s.), Malaya	7 0	6 9
Ayer Hitam (5s.), Malaya	1 1 6	1 1 6
Beralt (5s.), Portugal	1 6 9	1 5 9
Bisichi (2s. 6d.), Nigeria	3 3	3 0
Ex-Lands (2s.), Nigeria	1 9	1 9
Geevor (5s.), Cornwall	15 3	15 0
Gold Base Metals (2s. 6d.), Nigeria	1 0	9
Hongkong (5s.), Malaya	4 9	4 6
Jantar Nigeria (3s.)	2 0	2 3
Kaduna Syndicate (2s.), Nigeria	2 3	2 0
Kamunting (5s.), Malaya	8 6	8 3
Kramat Pulai (3d.), Malaya	3 0	3 0
Malayan Tin Dredging (5s.)	10 6	10 3
Mawchi Mines (4s.), Burma	2 6	2 0
Naraguta Extended (5s.), Nigeria	1 2	1 0
Pahang (5s.), Malaya	4 9	4 6
Siamese Synd. (5s.)	7 6	7 3
South Crofty (5s.), Cornwall	5 9	5 9
Southern Kinta (5s.), Malaya	16 3	16 3
Southern Malayan (5s.)	9 3	8 6
Southern Tronoh (5s.), Malaya	8 0	7 6
Sungei Besi (4s.), Malaya	12 0	12 0
Sungei Kinta, Malaya	15 6	15 3
Tronoh (5s.), Malaya	9 0	9 0
United Tin Areas (2s. 6d.), Nigeria	4½	4½
DIAMONDS:		
Anglo American Investment	7 13 0	7 12 3
Consol African Selection Trust (5s.)	11 9	12 0
Consolidated of S.W.A. Pref (10s.)	10 9	11 0
De Beers Deferred (5s.)	4 17 9	4 9 6
FINANCE, Etc.		
African & European (10s.)	2 17 6	2 18 9
Anglo American Corporation (10s.)	6 2 3	6 6 0
Anglo-French Exploration	1 2 0	1 0 6
Anglo Transvaal 'A' (5s.)	1 10 0	1 11 3
British South Africa (15s.)	2 11 3	2 18 0
British Tin Investment (10s.)	15 3	15 6
Broken Hill Proprietary	1 14 6	1 13 9
Camp Bird (10s.)	—	—
Central Mining	2 17 6	2 17 9
Central Provinces Manganese (10s.)	1 3 6	1 5 0
Consolidated Gold Fields	2 8 9	2 10 0
Consolidated Mines Selection (10s.)	1 14 0	1 9 3
East Rand Consolidated (5s.)	1 6	1 3
Free State Development (5s.)	4 6	4 3
General Exploration O.F.S. (2s. 6d.)	3 0	2 9
General Mining and Finance	4 1 3	4 4 0
H.E. Proprietary (5s.)	7 6	7 6
Johannesburg Consolidated	2 5 0	2 4 0
London & Rhod. M. & L. (5s.)	7 9	8 0
London Tin Corporation (4s.)	7 3	7 0
Lydenburg Est. (5s.)	11 9	11 3
Marsman Investments (10s.)	2 6	2 0
National Mining	1 0	1 0
Rand Mines (5s.)	3 10 0	3 12 3
Rand Selection (5s.)	1 15 0	1 16 3
Rhodesian Anglo American (10s.)	2 16 3	2 19 6
Rhodesian Corporation (5s.)	4 0	3 9
Rhodesian Selection Trust (5s.)	14 6	15 3
Rio Tinto (10s.)	2 12 0	2 14 3
Selection Trust (10s.)	3 0 9	3 8 9
South West Africa Co. (3s. 4d.)	16 3	16 3
Union Corporation (2s. 6d.)	1 18 9	1 19 9
West Rand Inv. Trust (10s.)	2 5 9	2 7 3
Zambesia Exploring	2 0 6	2 1 0

THE MINING DIGEST

A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

In this section abstracts of important articles and papers appearing in technical journals and proceedings of societies are given, together with brief records of other articles and papers; also notices of new books and pamphlets and lists of patents on mining and metallurgical subjects.

Diamond Drilling in Sandstone

Report of Investigations 5384 of the United States Bureau of Mines, by A. E. Long, gives the results of a study of "Diamond-Bit Performance in Sandstone." It is considered that diamond-bit performance and cost data accumulated in core-drilling sandstones reveal significant trends of economic interest. Large-size AA-Grade drill bort suffered less diamond loss per foot drilled than any other size or grade of diamonds assessed. Detailed analyses of the factors that affect diamond-bit performances—diamond size, diamond quality, bit size, bit type, percentage of core recovered, and physical characteristics of bit matrices—are assessed in the report.

The report points out that diamond bits cut most sandstones easily, with only nominal loss of diamond; however, the cuttings are highly abrasive and rapidly cut away the matrix surrounding the diamonds. Diamond losses are excessive when erosion of matrix progresses until diamonds become "over exposed" and are "rolled out" of the bit face. In the tests water was used in standard drilling techniques as a cuttings remover and bit coolant; on a few drilling projects the water was recirculated. Both hydraulic and screw-feed, petrol-powered, skid- and truck-mounted, surface drills ranging in size from 300- to 2,000-ft. A-rod capacity were used. Drills were commercial models produced by several manufacturers. Most of the drilling was done with commercially produced M-series and rigid and swivel-type X-series, double-tube core barrels. X-series, single-tube core barrels were used occasionally in extremely good coring ground; however, the project engineer discouraged the employment of single-tube core barrels and rarely condoned their use.

A total of 627 double-roundnose, 4 waterway, new or reset bits produced by several manufacturers was used; 141 were M series and 486 were bevel-wall bits. Diamonds were "random-set"; no effort was made to orient the stones in hard-vector directions. The composition and hardness of the three bit-matrix alloys used were:—

(1) *Beryllium-Copper.*—Copper with about 2% beryllium melted and cast in either a steel or carbon bit mould. Maximum Rockwell C hardness, when heat-treated, approximately 40.

(2) *Beryllium-Nickel.*—Nickel with about 0·7% chromium and 2·7% beryllium, melted and cast in either a steel or carbon bit mould. Maximum Rockwell C hardness, when heat-treated, approximately 50.

(3) *Powder Metal.*—Alloys formed by sintering a mixture of tungsten carbide and two or more metallic powders in a carbon bit mould. Iron, nickel, copper, zinc, and cobalt are some of the more commonly used powdered metals. Rockwell C hardness can be varied from 20 for tungsten carbide-free alloys to about 55 for those containing a large quantity of tungsten carbide. The powder-metal-matrix bits evaluated in this report were classed as medium-hard alloys by bit manufacturers. The chemical composition of each manufacturer's product differed but all had an approximate Rockwell C hardness of 45.

Diamonds were selected, sorted, and graded into quality and size ranges by the bit manufacturers. The metric carat (200 mg.), weight of the drill bort initially set in each bit and the weight of the resettable diamonds salvaged from each worn bit were also determined by the bit manufacturers. Drill-bort grades are listed and defined as follows:—

AAA Grade.—May also be designated as "Extra-," "Fine-," or "WA-1-Grade" drill bort. Round, clear, whole stones free of obvious cracks. This is the best-quality bort normally used in drill bits.

AA Grade.—May also be designated as "Medium-," "Good-," or "WA-2-Grade" drill bort. Clear, whole stones free from obvious cracks. Somewhat less round than AAA-Grade.

A Grade.—May also be designated as "Low-," "Regular-," or "WA-3-Grade" drill bort. Clear to cloudy, angular, whole stones.

Congos.—Encrusted, cloudy or dull, well-shaped, whole stones. Most bit manufacturers sort Congos into two grades. The round, sound, semitranslucent stones are considered the best and are listed as C-1-Grade Congos. The angular and somewhat crackled exterior-textured stones are considered to be low quality and are listed as C-2-Grade Congos. Current price per carat is $8·50 for the C-1- and $7 for the C-2-Grade Congos. The Congos used in the bits evaluated in the report were stones that would currently be a mixture of about 60% C-1 and 40% C-2 Grades.

AA-Grade, 8 to 10 per carat-size diamonds, suffer less loss of diamond per foot drilled than other sizes and qualities of diamonds assessed. Congo-quality diamonds of 20 to 30 stones per carat suffered the least loss. In sandstone most of the loss of diamond in all bits used was observed to be caused by the severe erosion of matrix and the resultant loss of whole diamonds through "rollout." The bits used in sandstone seldom become dull and drillers often run them until wear on the matrix has progressed beyond the danger point, which is reached when enough has been worn away to leave the diamonds slightly more than one-third exposed. Continued use of a bit beyond this critical stage results in loss of whole diamonds through "rollout."

Bits set with AA-Grade drill bort are more economical than those set with equal-size Congo diamonds, with one exception—the 20 to 30 stone per carat size.

Except for one inconsistency the data showed that the footage drilled per bit is commensurate with the size of diamonds used. A decrease in the size of diamonds is accompanied by a reduced amount of footage drilled per bit. This is not an unexpected result to readers familiar with the abrasiveness of the bit cuttings or sludge produced in drilling sandstone. The effect of this sludge, consisting of small sharp grains of quartz, on a bit matrix is analogous to that of sandblasting; the relatively soft bit matrix is easily cut away, while diamonds are virtually unaffected. The matrix erodes from small diamonds in a shorter time than from large diamonds. Hence, bits set with large diamonds can be run longer, with less chance of losing diamonds, than bits set with small diamonds.

The AA-Grade drill bort proved more economical than Congo stones, while in every phase of performance—feet drilled per bit, losses of diamond, and bit costs per foot drilled—the bits set with AA-Grade diamonds outperformed bits set with Congo stones.

Forty per cent. of the 42,665 ft. of drilling was done in sandstone in which core recovery averaged less than 90%; 81% of the poor core-recovery footage was drilled with bevel-wall bits used on swivel- and rigid-type, double-tube core barrels. A striking increase is noted in diamond losses and bit costs per foot drilled when the percentage of core recovered drops below 90%. Diamond losses and bit costs double when core recovery is poor as compared with diamond losses and bit costs when core recovery is good. Matrix wear was generally excessive on bits that average less than 90% core recovery in sandstone. As a result of this excessive matrix wear a considerable number of whole diamonds were lost and most of the diamonds salvaged from bits achieving less than 90% core recovery were chipped and broken.

A comparison of M- and bevel-wall-bit performance data shows that M bits consistently recover a higher percentage of core than bevel-wall bits, while the M bits also out-performed the bevel-wall bits in every respect. The M bits drilled more footage per bit with less diamond loss and at less cost per foot drilled than equal-size bevel-wall bits. An increase in bit size from AX to NX is accompanied by commensurate increases in diamond losses and bit costs per foot drilled and in footage drilled per bit. However, the high-level performance of the BX bits does not conform to the pattern established by the AX and NX sizes. The relative better performance of the BX bits is a phenomenon that many drillers have experienced and noted in drilling virtually all types of rock. Drillers have attributed the high-level performance of BX bits to the characteristics of a B-size drill-rod string, which has greater stability at high rotational speeds than either A- or N-rod strings. Research, substantiated by field tests, has shown that the cross-sectional area ratio between the rod and bore-hole size must be maintained within limits to minimize rod vibration.

The effects of the three different bit-matrix alloys on bit performance were studied. The beryllium-nickel-alloy matrix, in some respects, was better than either the powder metal or beryllium-copper matrix alloys. No single one of the three matrices proved outstanding in all respects and no definite performance trend was established. The ability of a bit matrix to withstand the abrasive action of the cuttings is the predominant factor in determining the life of a diamond bit in sandstone. Newer powder-metal matrix alloys that are quite resistant to abrasion have been developed and may prove especially effective as bit matrices in highly abrasive rock formations such as sandstone.

Conclusions

Data presented in the report covering the use of diamonds for core drilling in sandstone justify the following conclusions, it is thought:—

(1) Bits set with 8 to 10 per carat size, AA-grade, drill bort are more economical than those set with 10 to 20, 20 to 30, or 30 to 40 per carat size AA-grade diamonds or any size Congo stones.

(2) Bits set with 20 to 30 per carat size Congos are more economical than those set with 8 to 10, 10 to 20, or 30 to 40 per carat size Congos.

(3) Loss of core adversely affects bit performance, diamond losses, and bit costs.

(4) M bits consistently recover a higher percentage of core than bevel-wall bits.

(5) M bits are more economical for use in sandstone than bevel-wall bits.

(6) A decrease in diamond size is accompanied by a somewhat analogous decrease in feet drilled per bit.

(7) An increase in bit circumference is not always accompanied by an analogous increase in diamond losses and bit costs per foot drilled.

(8) No definite economic relationship was established between bits set with any one of the three types of matrix used.

Deep-Lead Tin in Australia

The "Recovery of Alluvial Tin from the Yithan Deep Lead" in New South Wales is described by A. A. C. Mason in the *Chemical Engineering and Mining Review* of Melbourne for January 15. The tin deposits of the area are approximately four miles north-west of Ardlethan and 343 miles west of Sydney. The deposits, from which alluvial tin has been shed, occur over an area of several square miles along the east margin of a north-south belt of biotite granite which has intruded Silurian sediments. In places the granite has been extensively altered along its prominent joint planes to quartz-tourmaline rock and to greisen. The principal tin mineralization is associated with this altered rock.

Following discovery of the field in 1912 a high-grade stanniferous alluvial lead was prospected and worked by numerous claim-holders from its source for a distance of approximately one mile downstream. At the downstream limit of these workings the lead was at a depth of approximately 35 ft. below the surface. Examination of these old alluvial workings in 1949 gave rise to the belief that the alluvial lead that had been worked was resting on a "false bottom" and that the contact between bedrock and the overlying alluvium was at some depth below. This fact gave rise to further thought

that another stanniferous alluvial lead might occur at a lower horizon, probably along the buried bedrock valley profile. A site was selected for boring where the bedrock valley entered a narrow defile as indicated from outcropping bedrock. A new stanniferous lead with values up to 31 lb. of metallic tin per cu. yd., lying on decomposed bedrock, was encountered in the third and fourth bore-holes at a depth of approximately 160 ft. below the surface. As a result of this discovery a shaft was sunk and the new lead was exposed lying upon decomposed granite bedrock at a depth of 160 ft. below the surface and overlain by clay. Cross-cutting of the lead followed, whereupon it proved to have a width of 57 ft. at this section. After further exploratory development and sampling underground a bulk sample of 14 cu. yd. from the complete cross-sectional area of the gutter exposed in the No. 1 shaft workings was taken and treated, resulting in a recovered grade of 22·9 lb. of metallic tin (Sn) per cu. yd.

At about the time the results of the bulk test became known another bore-hole traverse 800 ft. upstream cut the bedrock gutter and revealed values comparable with those obtained in the initial traverse. All these results determined that there was probably 9,000 cu. yd. of wash averaging approximately 23 lb. Sn/cu. yd., which, in the light of the nature, origin and likely further extent of the lead, was considered sufficient to establish a mining and treatment enterprise to exploit the deposit. Early development proved all strata to be dry and the gradient of the gutter to be fairly uniform and no steeper than about 1 in 60.

Equipment for the enterprise was planned with due consideration to the probable size and life of the deposit and the amortization that the value of the ore could profitably bear. The capital cost for equipment was £7,500 and provided a headframe, hoist, mine trucks, rails, mining tools, a concrete ore paddock and sluicing apron, nozzle pump, sluicing nozzle, gravel pump, elevated sluice box, return water pump, and power plant. Later a water-supply pipeline, storage tanks, an electric power plant, and an electric underground drill were purchased and installed out of profits. Until the electric drill was installed all shot holes were bored by hand-operated augers.

Mining

The physical nature of the deposit lends itself to mining by methods similar to those employed for mining flat seams of coal. In some places the lead was proved to be over 100 ft. wide. At the outset a room and pillar system of mining was instituted, but later a retreating longwall face was developed transversely across the lead with the direction of retreat towards the hoisting shaft. After considerable perseverance this system had to be abandoned. The 150 ft. of clay strata in the back, containing 2% to 3% moisture, could not be encouraged to collapse behind the retreating face in an orderly fashion along predetermined breaking lines and eventually built up a stress which relieved itself, when approximately 4,000-sq. ft. of area was opened up, by collapsing right to the working face. The thick homogeneous nature of the overlying clay, together with some dehydration of it following cutting of the mining slot, contributed to the difficulties of longwall stoping. Following this experiment the room and pillar system was reverted to.

Wash drives or headings of 6 ft. by 4 ft. cross section are driven along the centre of the lead both upstream and downstream from the main hoisting shaft for approximately 250 ft. in each direction. From the main headings stope cross-cuts of 5 ft. by 6 ft. cross section are driven to each edge of the lead at 36-ft. centres. Transverse pillars 6 ft. wide are also arranged at 36-ft. centres so that when each panel is extracted there is, in the direction of the course of the lead, no greater than a 30-ft. span of ground naturally unsupported. Extraction of the wash commences at the far end of each heading and each panel is taken out in a predetermined order to ensure a systematic retreat towards the shaft. By this method approximately 13% to 15% of the area of the wash is left as pillars, but effort is made to extract the wash completely from the centre of the gutter which commonly carries the highest tin values.

The main objective is to mine the deposit of wash lying directly in the bedrock gutter. To do this a mining height of 42 in. to 48 in. is necessary and involves breaking some overlying clay and some bedrock if the bottom of the gutter is very irregular. The headings, or topwash, which is separated from the bedrock wash by a narrow clay parting, is not everywhere co-extensive with the bedrock wash and in addition it has a lensing habit. This introduces difficulties and makes it uneconomical to mine both horizons of wash continuously over the area of the lead because in places the thickness of the barren or low-grade clay parting, lying between, becomes too great. In the course of development the centre of the headings or top wash gutter is determined and, where the grade warrants it, the thickest and best-grade centre section is extracted by increasing the mining height, often up to 7 ft.

The wash *in situ* is compacted and cannot be economically picked down ; thus, following development, the stope faces are bored with a Victor electric coal boring auger drill. The holes are charged and fired with semigel together with a primer of 60% AN gelignite. The sequence of extraction and direction of firing of the wash permits the clay lumps of no obvious value to be stacked in the worked out areas. For safety, timbering by means of stulls and cribbed bulkheads is carried out as the excavation in each panel advances, but on completion of each panel, if the roof conditions are considered safe, much of the timber is recovered and the roof encouraged to collapse when the men are working safely behind the transverse pillar line of subsequent panels. Working conditions in the mine are comfortable and clean.

The broken wash is hand-shovelled into ¼-cu. yd. kibbles on low trolleys and trucked to the hoisting shaft where the kibbles are hoisted from the trolleys direct to the surface.

Until recently all operations were conducted from the No. 1 shaft and all the wash hoisted was tipped direct on to a concrete sluicing apron alongside the shaft. Since then mining has proceeded along the lead and a new hoisting shaft has been brought into operation. The wash hoisted from this shaft is tipped into a bin and carted by motor truck to the sluicing apron.

Treatment

Wash, together with some clayey material, all in a dry condition, is dumped on a concrete sluicing apron and the heap subjected to nozzling with water at the rate of 320 g.p.m. and pressure of

35 lb. per sq. in. By this means the material is disintegrated and is streamed down the concrete floor with the water to a grating with one inch aperture. During the process of nozzling, disintegration, and streaming off, a rough concentrate of the coarser particles of tin oxide accumulates in the top corners of the apron. The finer particles of tin are carried through the grating with the gravel, sand, and slime fractions, leaving behind the stones and undigested clay lumps of greater size than 1 in. These oversize stones and undigested clay lumps are forked off the grating and trucked to a dump. The under-sized material collects in a sump and is pumped by means of a 4-in. gravel pump to a sluice box of 3 ft. by 2 ft. cross section and 120 ft. long with a slope of 1 in 24. The remainder of the tin oxide particles concentrate in this box, while the rest of the material gravitates to a tailing dump and settling dam.

The apron and sluice box are cleaned up once a week and the rough concentrate recovered is dressed up to 70% Sn grade by means of a simple wooden streaming box.

By means of this simple method of treatment 98·5% of the tin oxide content of the wash is recovered. The tailing and apron screenings contain approximately 0·22 lb. Sn per cu. yd. and 1·94 lb. Sn per cu. yd. respectively. Most of the loss is due to particles of tin oxide adhering to undigested clay balls.

New water used in the treatment operation is high at 590 gal. per loose cu. yd., equivalent to 780 gal. per solid cu. yd. of wash. The high consumption is attributed to the dry and clayey nature of the material at the outset and could doubtless be decreased by presoaking of the material and nozzling with water pumped in closed circuit. Steps are being taken to introduce such modifications to reduce consumption, although the cost of water supply is a small element in the total operating cost.

Prospects and Reserves

Recently the Bureau of Mineral Resources conducted a seismic geophysical survey over a considerable reach of country beneath which the lead was considered to occur. This resulted in the delineation of the main bedrock gutter together with some probable tributaries which were not previously suspected.

Sufficient reserves of wash are developed or indicated to ensure some years of life. From the results of past working, forward development, the geophysical survey, and the nature and origin of the deposit, it can be reasonably determined that the length of the main lead and tributaries is at least 3,000 yd. long, averaging about 22 yd. wide, and amounting to a mineable 88,000 cu. yd. estimated to contain a total of 1,180 tons of alluvial tin oxide concentrate. This is exclusive of prospects downstream.

Scope exists for the discovery of other buried stanniferous alluvial leads emanating from the same source as the Yithan Deep Lead described in this article. Quite apart from alluvial prospects mineralized out-cropping source rocks constitute tremendous potential for the establishment of a large open-cut tin-mining enterprise. Millions of tons of rock carrying about 14 lb. of tin oxide per ton actually outcrop or are so disposed as to be easily commanded by open-cut mining methods, preliminary plans for which have been developed.

Improved Metallurgy on a Rand Mine

A paper by A. H. Mokken published in the *Journal* of the South African Institute of Mining and Metallurgy for February discusses "New Developments in the Operation of a Gold Reduction Works." In it the author attempts to show the advantages that have accrued in recent years out of a study of the better use of native labour. In summary, says the author, various recent labour-saving devices and processes are described, including the canvas leaf (vacuum type) clarifier. Attention is focused on the importance of accurate measurement and control of quantities in milling and cyanidation and certain beneficial effects of this on recovery of gold are shown. An approach is suggested to the solution of certain remaining problems connected with the precipitation of gold on zinc. Processes utilizing inhibited acid to control formation of lime scale are described. The paper concludes with some observations on staff education and ends with a reiteration of the importance of man in the organization. Over the past ten years the total native strength of Van Dyk Consolidated Mines, excluding waste sorting and dumping but including pebble sorting, pebble haulage, and engineering maintenance, has shown a steady drop from 188 to 96, or from 1·90 natives per 1,000 tons milled per month to 1·24. It is estimated that about 30% of the drop is due to the introduction of entirely new processes and the remainder to the regular review of existing complements.

New developments together with indications of their labour saving aspects are listed as follows:—

Fork-Lift Truck.—Although the advantages of this machine for handling stores and equipment are to-day well known, it is worth recording its first impact on labour economies at the time of its introduction, ten years ago, when an immediate reduction of ten natives in the total works' complement was effected.

Rotary Filter Brush.—This improved brushing of filters which, until then, had been carried out by a gang of 12 natives, whose efforts became progressively weaker as the last filter was reached, reduced the time spent on brushing and patching of filter cloths by half an hour or more. It eliminated at least one job that required for its completion in reasonable time a relatively large labour force for which, however, no full employment could always be found during the remainder of the day.

Automatic Control of Rotary Filter Feed.—Compressed air is used to operate a Saunders valve. The air is fed from the mains through a small orifice and is controlled by a cistern ball valve, the plastic ball of which rests on the pulp in the pan. The compressed air costs of this new system are about 100d. per filter per month and the replacement cost of the ball valve, 10s.—a small price to pay for the far-reaching benefits that have resulted from its introduction.

Improved Pumping Facilities for Residue Pulp.—It was decided to raise pumps to floor level and to erect at an elevation a little above them a surge tank with stirring mechanism, fitted with a low and a high level alarm, to serve as a supply tank for the pumps under conditions of constant flooded suction which would be obtained by speed variation. Pulp from the puddler would be pumped with the existing single-stage pumps to the surge tank. The scheme was installed and proved most successful. It permitted the entire elimination of second-stage pumps at the slimes dam and reduced considerably the labour, European as well as native, associated with the former systems. An automatic device for control of pump speed is under consideration. Since the introduction of the new pumping arrangements the cost of pumping residue slime has dropped from 0·40d. per ton milled or 0·48d. per ton-mile to the present figure of 0·15d. per ton milled or 0·18 per ton-mile.

Automatic Opening and Closing of Reverberatory Furnace Doors.—The introduction of this automatic arrangement has eliminated the need for natives at furnace door controls. It has replaced the former strenuous but primitive manual operation and has contributed to a reduction in the requirements of native labour in the smelthouse.

Inhibited Acid for the Removal of Lime Scale.—As a result of the introduction of inhibited acid for the removal of lime scale, a subject which is described more fully at a later stage, the following economies in the use of labour have been achieved. Acid treatment of Merrill pit bags is carried out *in situ*. As a result the labour formerly associated with their removal from the pits and transport to and from the acid vat in the smelthouse has been eliminated. Also, by using inhibited acid to remove scale from the slats in the Crowe tank and from the walls of pipelines carrying cyanide solution, the labour that normally would have been required to dismantle, descale, or renew this equipment—a formidable undertaking when the inaccessibility and extent of this equipment is borne in mind—was reduced considerably. After the necessary connexions to pipelines had been made, the cleaning of these systems became the routine duty of the smelter, aided by one native.

Canvas Leaf Clarifier.—The substitution of canvas leaf clarification for sand clarification has lowered the labour demand of this operation in one particular installation from about 400 to 90 native-hours per month.

Extended Go-Devil Descaling of Mill Water Pipes.—By suitable alterations to the mill water supply system water power has substantially replaced manual cleaning of mill water pipes.

Mechanical Removal of Wood Chips from Mill Pulp Followed by Automatic Sampling.—Wood chips in mill pulp were previously removed by spreading the pulp stream over a wide punched-plate screen. To improve the position it was decided to design and install a mechanical wood chips eliminator and automatic sampler. The belt of the eliminator is fitted with two hinged scrapers and travels at a speed of 24 ft. per min. across a punched-plate screen placed at an angle of 10° in the final pulp launder. The holes in the screen are ¼ in. in diameter and the design was based on 34,560 cu. ft. of pulp per sq. ft. of screen per day. Power consumption is negligible. The automatic sampler is driven by a geared motor with an output shaft speed of 15 r.p.h. A long arm of ¼-in. brass rod fitted to the output shaft and counter-balanced by a similar arm engages a spoke of the sampler with every revolution and advances the sample spout by about 45°. In passing over a sample slot a sample runs into the bucket through a central pipe. Pulp for sampling is led by hose pipes from the delivery columns of the final pulp pumps to the funnel feeding the sampler. In this way pulp from one, two, or three pumps is mixed and sampled every 15 min. After installation of this sampler a close agreement between the gradings of mill and cyanide samples was obtained and it therefore allowed a more accurate assessment to be made of the work of each shift.

Tube-Mill Turning Gear.—This turning gear, obtained from a sister mine, and adapted to the Van Dyk installation, has contributed in great measure to a reduction in the relining gang from 12 natives to 9.

Replacement of the Crusher Thickner by a 12-in. Cyclone.—This substitution has eliminated the labour formerly associated with the repair and replacement of worn parts, lubrication, and supervision of the thickener.

Automatic Elimination of Wood Chips from the Crusher Classifier Overflow Pulp.—By fitting a scraper to each back hanger of the rakes in the duplex classifier their movement has been utilized to scrape wood chips from a punched-plate screen at the back of the classifier. This innovation has replaced two natives, one on each shift.

An Electric Hoist and a Large Impact Wrench for the Handling and Repair of Symons Crusher Parts.—The acquisition of this equipment has allowed a reduction from 5 to 2 natives in the crusher plant maintenance gang.

Annealing of Symons Crusher Bowls.—The present practice of annealing crusher bowls before welding has eliminated a considerable labour and repair bill formerly associated with the repeated handling and welding of these castings. The success of this new method has now virtually eliminated the need for welding, as castings are annealed soon after the first cracks have appeared. The annealing technique has recently been extended to a crusher head and shaft.

Feeding of Unslaked Lime.—The replacement of two natives, one on each shift, has been effected by installing an unslaked lime feeder.

Rates of Pay

In order to arrive at an equitable wage standard for the different classes of work a slight modification of the Group's evaluation system for underground native employees was used with good effect. Under this system each job was evalued under such headings as :—

(*a*) Training and job experience required.
(*b*) Need for making decisions.
(*c*) Acceptability to and co-operation with others.
(*d*) Physical effort required.
(*e*) Exposure to possible injury and so on.

Staff.—In the interest of technical advance in reduction works training of senior operators in such subjects as chemistry, physics, mathematics, and mechanics is strongly urged. Although facilities for acquiring such knowledge do exist its possession is not compulsory. There is no doubt, however, that, armed with even an elementary knowledge of the above subjects, operators should feel more secure in understanding the principles governing

the processes under their control. In addition they would become more alive to potential improvements of a technical nature. As far as graduates are concerned greater facilities for post-graduate study and travel should contribute towards closer understanding of, and renewed interest in, their work. Such facilities would in themselves advertise our operations abroad and place before the young men contemplating entry to the industry prospects beyond mere monetary rewards.

Conclusion.—By a scientific approach to a variety of problems a number of technical improvements have been effected which together have contributed to an increased gold recovery. In spite of these material changes the main factor responsible for the additional revenue has been, and still is, the the man on the job, in all grades of employment, European as well as non-European. His importance, his pride, his ability—whether actual or potential—his interest in his job have, amongst others, been a main consideration. In the absence of monetary incentives these attributes have been respected, stimulated, and retained by such means as pleasant working surroundings, general cleanliness, provision of necessary facilities, and by the constant recognition of any constructive endeavour through joint consultation and the daily recording on a continuous graph of the results of each operator, so to remain a permanent reflection of the pride in his job.

Iron Ore Deposit in Ghana

The Report of the Director of Geological Survey in Ghana for 1955–56 includes an account by J. P. Crook of deposits of haematite iron ore South of Shiene, in the Yendi District. The occurrence has been known to the Survey for some time, but little attempt was made to map it in detail since the locality of the ore is so remote. However, in relation to the Volta project, water transport to within about 30 miles of the ore deposits has become available.

The ore forms a series of sharp, bare, hill ridges in an area bounded by the hills just north of Shiene—Warlung on the south-west and the French boundary to the east. The range of hills in which the ore lies trends almost due north–south on the extreme east of the area. South of Darwinyere the boundary with Togoland under French Trusteeship lies along the top of the hills. The hill range consists of sinuous, horseshoe and crescent-shaped ridges in the north and linear north–south ridges in the south. The horseshoe ridges lie entirely within British territory, while the north–south ridges mark the boundary with French territory. The highest points of the hills rise over 1,000 ft. above the surrounding plain. On examination the horseshoe ridges prove to be a series of synclines, often cross faulted, the larger faults causing repetition of the nose of the structure. The areas between the ridge tops are completely covered by scree and lateritized scree. In general altitude is related to dip, low dips giving increased height and smooth profile and high dips giving low separated ridges. Thrusting complicates this simple relationship. In the north a vertical component of the thrusts has led to differential movement between synclines; in the south overthrusting has led to thickening of the ore with consequent increased elevation. Below the hills, both to east and west, are flat-topped platforms which gently slope away to merge into the general levels of the plain about two miles from the ore hills; more often, however, they are truncated before this distance is reached. Their surface is a combination of bare iron-pan and poor soils which support clumps of grass and stunted trees. Always the edge has been eroded to form a cliff feature which becomes higher towards the hills. Occasionally a sharp trough separates platform and hill.

The best-developed platform lies to the south of Darwinyere. The edges are generally covered by a conglomeration of iron-pan blocks and, nearer the hills, lateritized scree. Near the hills, too, blocks of quartzite project from the cliff; they appear to be lateritized erosion surfaces. In the embayment between the ores and the French frontier more quartzites occur. One of these is very prominent topographically and of considerable thickness, forming a series of hills parallel to the strike of the haematite. At Shiene these quartzite hills are low, being broken by a tributary of the Oti. The quartzite here appears to form part of the western limb of a syncline closing to the north, judging from examination of poorly-developed current bedding. It is worth noting that the surface of the quartzite is a mass of boulders. Between this quartzite and the hills two lines of quartzite boulders occur following the general north–south strike of the region. They are developed in a lateritized erosion surface and no solid geology was seen. The relationships between the various quartzites are therefore obscure. It is most likely that the Shiene quartzite is younger than the haematite schists. Therefore it is not the same as that seen at the base of the ore.

To the west of the hills rocks of the Oti series form a rolling grassland with an extensive blanket of laterite. Iron pan outcrops frequently. Where there is no laterite cover it is common to find that deep weathering has given rise to an argillaceous product. The solid rocks are only seen in stream courses. The rocks are generally fine friable sandstones and mudstones with a few greywackes as thin bands up to 1 ft. thick. The rocks are very varied in appearance; yellow nodular mudstones form the bulk but they are interspersed with banded mudstones and sandstones with characteristic colours and textures. It should be possible to map the horizons in fair detail by intensive pitting.

Superficially the haematite rocks appear to be younger than the Oti series. The Oti rocks and the haematite near their junction both dip to the east at angles in the 50° to 75° range and have concordant strikes. The reasons for reversing the sequence will be examined later. The haematite schist occurs interbedded with sandstone. In outcrops this sandstone is often leached to a greater or lesser extent. Sometimes it has been completely removed, giving the outcrops a "slashed" appearance. More commonly, however, the process has been more moderate and apparently only the cement has been partly removed leaving spongy textured masses of oolitic grains. Quite frequently, especially in the north–south ridges, the sandstone laminae have been converted to jasper. Often this conversion takes the form of a thin selvedge between ore and sandstone. More unexpected were a few cases where lenses of jasper were found within lenses of sandstone;

this seemed to indicate a jasperization process working outwards but may merely be the result of peculiarities in the original sedimentation. The possibility that the sandstone represents a leached quartzite has been considered. There is no positive evidence that this is the case, but the possibility cannot be excluded.

The ore itself is usually a rich red-brown colour with sub-metallic lustre becoming metallic on joints. Occasionally minute bands of lustrous metallic crystals parallel the bedding ; these are believed to be specular haematite. In some tension gashes poorly-developed earthy-red hexagonal crystals appear. Where the ore has been highly contorted wafer-thin bands of haematite tend to fill any void.

It is difficult to arrive at an accurate estimation of the proportion of sandstone to ore in the hills. Often the more competent sandstone has been thoroughly smashed to an amorphous breccia during folding. As soon as the folding becomes more than gentle a boudinage structure develops, becoming more and more irregular until either a mass of tabloid blocks of sandstone occur cemented by the ore, or a solitary chunk of sandstone occurs in isolation in an otherwise solid block of haematite. Where the ore sandstone laminae occur unbroken approximately one-third is sandstone. It is not easy to prove the structure of the area. Within the ore outcrops, breccias, minor fold, and slickensided joint surfaces all indicate thrusting from the east. From a consideration of the map it is obvious that a major break in the type of structure occurs in the vicinity of Darwinyere ; to the south lie the multiple ridges of ore.

To the north the Oti series are folded into a moderately sharp anticline ; there is no trace of the vertical limb seen in the south and the break in the two types of ore structure is therefore taken to extend into the younger rocks. The ore synclines are asymmetrical and the eastern limb is always the steeper dipping. The axial planes thus dip to the east. It is a peculiarity that the faulting associated with any one syncline causes downfaulting outwards from the centre of that syncline. Another interesting relationship is one that led to an early problem. This is the bifurcating ore outcrop. This is caused by one limb of the downfaulted nose of the syncline resting against the nose of its parent structure. This is caused by the " parent " being thrust westwards by exactly half the wavelength of the fold at the position in which the downfaulting took place. Nothing was seen to suggest that the ore is of metasomatic origin.

Trade Paragraphs

George Cohen Sons and Co., Ltd., of Trinity Road, Kinsbury, Tamworth, Staffs., announce that this is now the address of their Raw Materials Division, which has recently moved from Birmingham.

International Combustion, Ltd., of 19, Woburn Place, London, W.C. 1, have opened a new office in Cardiff with Mr. R. W. Allison in charge, at 22, St. Mary Street (telephone Cardiff 26648).

Hugh Wood and Co., Ltd., of Gateshead-on-Tyne, announce that their London office has been moved to new premises at Royal London House, Finsbury Square, E.C. 2, where the telephone number is Monarch 3273.

Twiflex Couplings, Ltd., of The Green, Twickenham, Middlesex, a subsidiary of Sheepbridge Engineering, Ltd., announce the introduction of Twiflex disc brakes (incorporating Dunlop disc brake operating units) to their range of power transmission equipment for all types of heavy industrial applications.

Atlas Copco (Great Britain), Ltd., of Beresford Avenue, Wembley, Middlesex, have compiled a booklet which is well illustrated with drawings in a humorous vein and contains a wealth of useful information for the user of air-operated tools under the title of " Working in Air," of which copies are available on request.

W. G. Bagnall, Ltd., of Stafford, have received an order from Altos Homos De Vizcaya S.A., Sagunto, Spain, for two 105-h.p. diesel shunting locomotives for use on a metre gauge railway. Each weighs 16 tons, will haul 580 tons on level track, and is equipped with an engine which develops the rated horsepower at 1,500 r.p.m. manufactured by **W. H. Dorman and Co., Ltd.,** of Stafford.

Sturtevant Engineering Co., Ltd., of Southern House, Cannon Street, London, E.C. 4, have produced a new publication (No. 8704) on their mechanical air separators for effecting air classification in conjunction with fine grinding. Among applications illustrated is lime hydrating and minerals that have been handled include almumina, asbestos, barytes, bauxite, ilmenite, magnesite, monazite, rutile, and zircon.

Le Grand, Sutcliff, and Gell, Ltd., of Iddesleigh House, Caxton Street, London, S.W. 1, announce that they have opened a Middle Eastern office in Baghdad. The office is being established to represent LeGrand ADSCO, Ltd., and to control its drilling operations throughout the Arab world. From the new office Site Investigation Co., Ltd., will control its geological and geophysical operations, which include mineral surveys in Iraq, Lebanon, Syria, Iran, and Qatar.

Visco Engineering Co., Ltd., of Stafford Road, Croydon, Surrey, are now producing a new type of dry filter which is the subject of an illustrated leaflet. The new filter has a throw-away element made of a new synthetic fibrous material the fibres of which are not dislodged by air movement. The overall size is the same as that of the standard vertical panel type oil-wetted air filter so that where two stages of filtration are required both types can be fitted in the same housing.

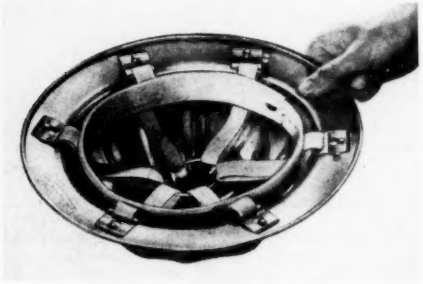
Distington Engineering Co., Ltd., of Workington, state that four shaker conveyors complete with duckbill loaders of their manufacture are in use in the construction of the tunnel under the Thames between Dartford and Purfleet. Working in a sticky mixture of gravel and chalk and with gradients of up to 1 in 10 the loaders scoop up the material and deposit it on the conveyors, each of which is capable of being extended to a length of 100 yd. From the conveyors the material passes to belt-conveyors which load it into crushers, where it is mixed with water and pumped to the surface.

Wilfley Mining Machinery Co., Ltd., of Rushden, Northants, manufacturers of the Wilfley concentrating table, announce that tests on the new " Curnow " type laminated spring deck suspension

have now been successfully completed. This new suspension gives an almost frictionless deck movement and at the same time eliminates the necessity of oil-filled slipper housings. Power consumption has been reduced and performance increased. The machine is particularly silent in operation. The first of these new machines is being installed at Doncaster for the recovery of metallics from foundry residues and models will be available for the export market in the very near future. Some further particulars are expected to be available later.

Union Carbide International Co., of 30 East 42nd Street, New York, in a new four-page bulletin describe their complete line of carbon and graphite products for the chemical processing and other industries. Including both National brand carbon and graphite and Karbate brand impervious carbon and graphite products, the bulletin lists their chemical and physical properties and gives data on shell and tube heat exchangers; cascade, concentric, and immersion type heat exchangers; centrifugal pumps, entrainment separators; pipe, valves, and fittings; towers and accessories, and brick, structural shapes, and cements. Other products discussed are anodes and backfill for cathodic protection, electrolytic anodes, and activated carbon.

Panorama Equipment Ltd., of 29–36, Seymour Mews, Wigmore Street, London, W. 1, make available some details of their aluminium "Lifeguard" safety helmet, as illustrated, the helmet bears the Kite Mark under Licence 2820, issued by the British Standards Institution, to Specification 2826 : 1957 for heavy-duty helmets. Tests



that have been carried out confirm also that the helmet more than adequately complies with all the safety standards for the North American Continent. The new helmet is the result of some two years' development and incorporates all the important features which are required to prevent users from receiving fatal or serious injuries, it is stated. The illustration shows the harness adjustment with its six-point suspension, high-quality leather, and webbing cradle straps that are easily adjustable.

Sir W. H. Bailey and Co., Ltd., of Patricroft, Manchester, have been appointed sole distributors for the flow indicating equipment produced by the Dukes and Briggs Engineering Co. This equipment at present comprises their "Telicator" visual flow indicators, although other models are shortly going into production which will provide a full range of indicators to cover many requirements. The "Telicator" indicator is a simple compact unit designed for high or low pressure systems and can be successfully used for extremely high or low rates of flow at any viscosity. Comparative flow can be readily gauged by a glance at the rate at which the rotor is revolving, this rotor being clearly visible through its cartridge case of perspex or glass. Among applications are forced lubrication systems and water supplies for cooling purposes, a special model being available for use with opaque liquids.

Nordberg Manufacturing Co., of Milwaukee, Wisconsin (London office : 19, Curzon Street, W. 1), have compiled a 12-page three-colour brochure, which contains a concise description and illustration of each major type of Nordberg built machinery. Photographs of the manufacturing facilities at Nordberg's Milwaukee and St. Louis plants introduce the reader to the company and the latest designs of diesel, duafuel, and spark-ignition gas engines are shown, the bore, stroke, and horsepower range of each being given. Symons crushers and screens are illustrated in block-out photographs and the principal features and capacities of each are included in the accompanying text. Grinding mills, rotary kilns, and mine hoists of both drum and friction type are described. Eighteen railway track maintenance machines, five of them recent developments, are shown in operating views.

Metropolitan-Vickers Electrical Co., Ltd., of Trafford Park, Manchester, issue some notes on battery locomotives supplied to collieries of the National Coal Board. Recent orders have included two 14-ton flameproof machines for Rothes colliery, which have now been commissioned, while a further two have been ordered and six of the same type are on order for Bilston Glen colliery. The locomotives have driver's cabs at both ends and employ a triple combination control, which is described as very economical in its demands on the battery. In operation the two halves of the 200-V 420-Ah battery are first connected in parallel while the two motors are in series; the battery halves are then connected in series with the motors still in series and finally the motors are connected in parallel. In each of these combinations field weakening gives an additional intermediate running notch. The whole scheme enables shunting and starting operations to be carried out with the least possible waste of battery power in the starting resistors.

Caterpillar Tractor Co., Ltd., of 55, St. James's Street, London, S.W. 1, in a recent statement refer to engine power loss at high altitudes which can be eliminated on their D6 tractor by the use of a normalizing kit now available. This is the third machine in the company's range to be provided with neutralizing kits; D7 and D8 tractors have already been equipped to carry them. The kit, which consists of a turbocharger and all manifolds needed to mount it on the tractor engine, overcomes the cause of high altitude power loss—*viz.*, insufficient oxygen to permit complete combustion of fuel. The turbocharger delivers air to the inlet manifold at greater than atmospheric pressure, thus permitting complete fuel combustion and restoring sea-level horsepower up to 10,000 ft. altitude. For example, when operating at an altitude of 8,000 ft., the normalized D6 will operate at the machine's full sea-level rating of 90 h.p. whereas the standard D6's capacity at the same altitude would be only 79 h.p.

Consolidated Pneumatic Tool Co., Ltd., of 232, Dawes Road, London, S.W. 6, announce that they

are now supplying C.P. Seco steel with stainless-steel linings to eliminate the incidence of failure due to corrosion of the inner wall. This development has been brought about by the greater stresses involved when the steel is used in conjunction with modern high-efficiency drills. With the incorporation of this lining into a tungsten carbide tipped drill rod variations in the structure at heat treatment points have now been nullified and failure initiated by corrosion during rod life eliminated, it is stated. Another note from the company refers to a new version of the " Power Vane " oil-flooded rotary compressor which is powered by a type 592E Ford diesel engine, developing 45 b.h.p. at 1,730 r.p.m. The compressor, a two-stage unit giving a full 120 c.f.m. F.A.D. at 100 p.s.i., is driven through a flexible friction drive and is fitted with automatic variable-speed capacity control which regulates the engine speed according to demand.

Mond Nickel Co., Ltd., of Thames House, Millbank, London, S.W. 1, in the *Nickel Bulletin* for February include abstracts on recent developments in the application of ultrasonics to electrodeposition, the influence of electrodeposited coatings on the cracking of high-strength steels, and the benefits to be derived from the use of nickel pre-flashed sheet for vitreous enamelling. A comprehensive paper deals with the resistance of tin-alloy deposits to atmospheric corrosion ; others are concerned with evaluation of various accelerated corrosion tests in terms of their ability to predict behaviour of coatings under atmospheric conditions. The latest issue of the *Inco-Mond Magazine* contains a review of the Canadian nickel industry and includes a flow chart illustrating the mining, smelting, and refining operations of the group. Reference is also made to the availability of films illustrating these activities. There are also some contributions on certain Swedish enterprises, notably Uddeholm and Stora Kopparberg Bergslegs.

Godfrey Holmes (Plastics), Ltd., of Wragby, Lincs., release some particulars of a new polythene-nylon detonator box, designed and produced by the company in conjunction with the National Coal Board and Imperial Chemical Industries Plastics and Explosives Division. The box, which is provided with belt loops, has already been approved for use and adopted by several areas and is of interest to all who handle detonators. It is strongly constructed in high-duty two-tone polythene with easy-clean surfaces and weighs 15 oz. empty. The nylon lid has a sliding action, self-locking in a central position, and when opened exposes only ten detonators at one time. There is a recess for the employee's number. The brass lock is operated with a standard shot-firing key. Inside the box are separate compartments for each detonator, with provision for 20 in all. There is no metallic contact between the inner compartments and the outside of the box. The manufacturers claim that the new detonator box, known as the Lincoln Imp, is shockproof, virtually indestructible, functionally sound, and economically priced.

Joberg, Ltd., of 53, Barbican, London, E.C. 1, issue a leaflet describing the R-J methane indicator, illustrated here, which is suitable for use underground. The instruments, of which a range is available, compare a gas mixture under test in one chamber with a reference gas (usually air) in the other chamber by interferometric methods. They are very simple and measure with laboratory

accuracy to sensitivities of 0·1%, 0·02%, and 0·005%. The air to be tested is sucked into the sampling chamber through a filter by squeezing a rubber aspirator and the percentage of the gas of interest is read directly off a scale visible through the eyepiece. The procedure is repeated for further tests. Because the instrument uses the principle of index of refraction it is possible to measure a great range of combustible and toxic gases with consistent accuracy—such as, methane, petrol vapour, hydrogen, freon, and carbon dioxide. Unwanted gases in the mixture under test are filtered out by suitable absorbents in the instrument before entering the sampling chamber. One instrument can sometimes be used for a range of gases by changing the absorbent. A long rubber tube supplied with the instrument allows samples to be taken from inaccessible or dangerous places without exposing the operator.

F. Perkins, Ltd., of Peterborough, point out that among items shown at a recent London exhibition was their " Four 99 " 1·6 litre diesel engine with a new combustion system specially designed for the smaller size of cylinder (3 in. bore and 3·5 in. stroke). The upper part of the combustion chamber is hemispherical in shape and is machined into the cylinder head. The lower half of the chamber is formed by an inserted machined plug, which contains the throat or oval port connecting chamber to cylinder. Fuel is injected into the combustion chamber by means of a pintle type nozzle. During the greater part of the compression stroke air is transferred into the chamber from the cylinder vertically upwards through the oval port and produces swirl in the chamber, moving transversely across the nozzle. In the later stages of compression the direction of air transfer is gradually changed from vertical to horizontal. When combustion is about to begin the final part of the air is transferred violently from the head *via* the special-shaped passages machined in the head and chamber insert horizontally into the combustion chamber to promote considerable turbulence in the mixture of fuel and air already present. By this means, it is stated, complete combustion is promoted and the maximum possible quantity of air is utilized.

English Electric Co., Ltd., from the welding electrode division at Clayton-le-Moors, Accrington,

announce that they have introduced a revolutionary type of electrode which is designed for cutting grooves, gouging, piercing, or removing surplus metal and which is equally effective on all steels, cast iron, and non-ferrous metals. Known as "Groovees" they can be used with ordinary a.c. or d.c. welding plant without additional equipment and leave a clean scale-free surface that requires no further preparation before rewelding. As the electrodes contain a steel-wire core there is no chance of carbon pick-up, it is stated. For cutting grooves the electrode is held at an angle to the work surface pointing in the direction of travel. After an arc is struck the electrode is moved rapidly along the line to be gouged. The force of the arc cuts the groove and removes the molten metal giving a clean bright finish. For gouging out defects in castings a series of overlapping grooves are cut in alternate directions making it possible to remove a defect of considerable depth. When piercing holes or removing rivets the electrode is held perpendicular to the workpiece, the arc struck and held until the metal flows, and then the electrode moved into the molten pool. With manipulation holes up to $\frac{3}{4}$ in. diameter can be pierced in plate up to $\frac{1}{2}$ in. thick and rivets removed from much thicker plates. There are two standard sizes—10 swg and 8 swg.

British Standards Institution, of 2, Park Street, London, W. 1, issue a note on British Standard for industrial safety helmets (light duty) (No. 2095 : 1958). This revised publication marks yet a further step forward in the provision, through standards, of protection against head injury. Safety helmets conforming to this revised specification, as well as those made to the recently-issued B.S. 2826, relating to heavy-duty helmets, are designed for workers engaged in mining, quarrying, and similar occupations. The note suggests that it is for safety officers and other buyers of helmets to decide (in consultation with their suppliers) which type of head protection is required for any particular category of worker. In addition to specifying requirements for construction and materials the new Standard contains details of the tests which light-weight helmets must undergo, the basic one being to assess the shock-absorbing properties of a helmet by a new method. An 8-lb. steel ball is dropped through 3 ft. 6 in. on to the crown of the helmet mounted on a headform. The unabsorbed energy transmits its force through another steel ball under the headform to a strip of aluminium. The indentation thus produced is a measure of the absorptive quality of the helmet. Other tests are for flammability, resistance to penetration by sharp objects, and electrical insulation (where this is required). Provision is made in the standard for the use by manufacturers of The Institution's Kite certification mark.

RECENT PATENTS PUBLISHED

☛ A copy of the specification of the patents mentioned in this column can be obtained by sending 2s. 8d. to the Patent Office, Southampton Buildings, Chancery Lane, London, W.C. 2, with a note of the number and year of the patent.

26,655 of 1954 (791,916). SHERRITT GORDON MINES. Extraction of Copper values.

33,386 of 1954 (791,121). UNITED KINGDOM ATOMIC ENERGY AUTHORITY. Production of niobium.

35,819 of 1954 (791,151), 29,351 of 1955 (791,152), and 30,351 of 1955 (791,153). HORIZONS TITANIUM CORPORATION. Fused-salt baths for the electro deposition of polyvalent metals.

37,325 of 1954 (791,857) and 5,125 of 1955 (791,859). STAMICARBON N.V. Wet screening process and apparatus.

5,484 of 1955 (792,151). BRITISH TITAN PRODUCTS Co. Chlorination of titaniferous materials.

7,507 of 1955 (791,437). CHEMICAL CONSTRUCTION CORPORATION. Ammonia separation process.

9,843 of 1955 (792,118). WILFLEY MINING MACHINERY CO. Separating machines of the reciprocating table type.

32,854 of 1955 (792,235). FARBENFABRIKEN BAYER, A. G. Recovery of magnesium.

35,244 of 1955 (792,454). ORE AND CHEMICAL CORPORATION. Gravity separation in liquid media.

35,919 of 1955 (791,410). SOC. D'ETUDES CHEMIQUES POUR L'INDUSTRIE ET L'AGRICULTURE. Separation of potassium and sodium ions.

35,093 of 1955 (792,300) and 1,563 of 1956 (791,783). IMPERIAL CHEMICAL INDUSTRIES, LTD. Manufacture of titanium.

12,007 of 1956 (791,366). TITAN CO. AKT. Production of metallic iron and titanium concentrates.

18,462 of 1956 (791,575,. METALLGESELLSCHAFT, AG. Electrostatic purification of waste gases.

NEW BOOKS, PAMPHLETS, ETC.

☛ Publications referred to under this heading can be obtained through the Technical Bookshop of *The Mining Magazine*, 482, Salisbury House, London, E.C. 2.

Mines and Quarries Act, 1954 : The Law Relating to Safety and Health : Vol. I—Mines of Coal. Paper covers, 355 pages. Price 11s. 6d. ; Vol. II—Mines of Stratified Ironstone, Shale and Fireclay. Paper covers, 327 pages. Price 10s. 6d. London : H.M. Stationery Office.

Statistical Summary of the Mineral Industry : Production, Exports and Imports, 1951–1956. Paper covers, 371 pages. Price 27s. 6d. London : H.M. Stationery Office.

Zinn und Wolfram : Die Metallischen Rohstoffe. Band 11. By Dr. FRIEDRICH AHLFELD. Cloth, octavo, 212 pages, illustrated. Price DM45. Stuttgart : Ferdinand Enke Verlog.

Die Blei-Zinc-Erzvorkommen des Ruhrgebietes und seiner Umrandung. By F. BUSCHENDORF, M. RICHTER, and H. W. WALTHER. Monographs of the German Lead-Zinc Deposits, vol. I, part 2 : The Christian Levin lode. Paper covers, 162 pages, illustrated, with 25 plates. Price DM30. Clausthal-Zellerfeld : Gesell. Deutscher Metallhätten und Bergleute C.V.

Overseas Newspapers and Periodicals : 6th edition, 1958. Paper covers, 212 pages. Price 12s. 6d. London : Publishing and Distributing Co., Ltd.

The Enemies of Timber. By CLAUDE SISLEY. Paper covers, 40 pages, illustrated. Price 2s. 6d. London : Cuprinol, Ltd.

Diamond Resources of British Guiana. Compiled by E. R. POLLARD, C. G. DIXON, and R. A. DIYARDIN. Geological Survey Bulletin No. 28. Paper covers, 45 pages, with maps. Price $1·00. Georgetown, Demerara : Geological Survey.

The Geology and Mineral Resources of the Kota Belud and Kudat Area, North Borneo. By E. A. STEPHENS. Geological Survey Memoir 5. Paper boards, 137 pages, illustrated, with maps. Price 14s. Kuching, Sarawak : Geological Survey Department.

Selected Index to Current Literature

This section of the Mining Digest is intended to provide a systematic classification of a wide range of articles appearing in the contemporary technical Press, grouped under heads likely to appeal to the specialist.

* Article in the present issue of the MAGAZINE. † Article digested in the MAGAZINE.

Economics

Automation, Industrial : *Study, Mining.* Automation in the Mineral Industries. J. McCASLIN, *Min. Engg.*, Mar., 1958.

Mining, Australia : *Prospects, Review.* 1958 Forecast of the Australian Mining Industry. J. A. DUNN, *Chem. Engg. Min. Rev.* (Melbourne), Jan. 15, 1958.

Mining, Canada : *Future, Review.* Outlook for Mining in Canada. A. J. ANDERSON, *Western Miner*, Feb., 1958.

***Mining, South Africa :** *Review, Annual.* South African Mining in 1957. L. A. WASPE, THE MINING MAGAZINE, Apr., 1958.

†Production, Australia : *Tin, N.S.W.* Recovery of Alluvial Tin from the Yithan Deep Lead. A. A. C. MASON, *Chem. Engg. Min. Rev.* (Melbourne), Jan. 15, 1958.

Production, United States : *Borax, California.* New Borax Open Pit Swings Into Peak Production. S. DAYTON, *Min. World* (San Francisco), Mar., 1958.

†Resources, Africa : *Iron, Ghana.* Iron Ore Deposit in Ghana. *Ghana Geol. Surv. Rept.*, 1955–1956.

Resources, Australia : *Abrasives, Natural.* Natural Abrasives. L. KALIX, J. BARRIE, *Min. Res. Aust. Summary Report* No. 41.

Resources, United States : *Oil, California.* Petroleum in California. *Calif. Div. Mines Min. Inform. Service*, Vol. 11, No. 3, Mar. 1, 1958.

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